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Llegó La Luz: A Case Study of the Impacts of Solar Photovoltaic Electricity in Las Balsas, Ecuador

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Llegó La Luz: A Case Study of the Impacts of Solar Photovoltaic Electricity in Las Balsas, Ecuador

by

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Dedication

To Anna: *Fur immer danze, glaube, und draume.*

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Abstract

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In this thesis I study the impact of electrification using solar photovoltaic panels in the rural Ecuadorian community of Las Balsas. Many large-scale development organizations like the World Bank promote small-scale renewable energy technologies like solar photovoltaics as being crucial in helping poor rural communities generate more income. My research however, both in the field and in the literature, shows income generation from these projects tends to be minimal. I find that the introduction of solar electrification is most important for social applications like music, movies, cell phones, and lighting.

FEDETA, the NGO that installed the solar photovoltaics, promotes the development project not as a neoliberal market-based income-generation project, but rather as a humanistic improvement in the "quality of life" of local residents. I analyze this goal of the project in light of the development theories developed over the past few decades. I question how well solar photovoltaics fits into the "small is beautiful" appropriate technology sector.

While solar photovoltaic systems have the potential to build small-scale islands of autonomous electricity production in a more environmentally sustainable manner than grid electricity based on fossil fuels, I caution that this is not necessarily the most equitable way to provide electricity to the rural poor in developing countries. While solar home systems have much potential to provide (often minimal amounts of) electricity to extremely rural areas, the service provided is in many cases inferior to grid electricity.

While solar photovoltaic technology does provide many potential benefits in areas not reached by grid electricity, NGOs and policy makers should be wary of seeing the technology as a panacea for sustainable development. Solar photovoltaics as a technology has a long way to go to provide energy services comparable to that offered by most grid systems. As with any technology its actual use is not predetermined, but rather is influenced by the local social and cultural contexts.

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Chapter 1: Introduction

In July of 1977 New York City experienced heavy electricity blackouts due to several lightning strikes during a massive heat wave. Even though electricity access was restored within two days, the city experienced widespread looting, vandalism, and arson. While it is important to note that the city was going through a severe financial crisis at the time, the direct connection between rampant vandalism and lack of electricity did not go unnoticed. In the aftermath of the confusion "a newspaper columnist quipped that just one flick of a light switch separated civilization from primordial chaos" (Ekirch, 2012). While obviously being hyperbolic, the columnist did raise an issue that is often overlooked. We frequently tend to take electricity for granted even though it forms a large part of most people's daily activities and is the bedrock that "underpins modern civilization" (Yergin, 2011, p. 345).

Despite the fact that much of the world cannot function normally, or even at all, without electricity, there are still 1.3 billion people, one-fifth of the world's population, who do not have electricity access. How do they experience life when the "modern" world is incapable of functioning without it? What is being done to provide electricity access to these areas, what technologies and methods work best, and how does electricity access impact their lives? These are the questions that led me to the research presented in this thesis.

REGIONAL OVERVIEW

In this paper I analyze the effects of solar photovoltaic (PV) electrification in the small rural community of Las Balsas, located in northwestern Ecuador. I look closely at how solar PV electricity impacts community and family life and what the implications are for poverty alleviation and improving quality of life. This case study is based on field research conducted during the summer of 2013.

I look at community members' responses to receiving access to electricity. I study how they use the electricity, and I analyze their discourse around how the project affected their lives. I also look at the goals of FEDETA[1], the NGO that installed the project, and whether those goals were met, and how those goals tie into a broader development framework.

Geography

Las Balsas is a community of 20 houses, 11 of which were inhabited at the time of research. The community is located in the Mache-Chindul Mountains in Esmeraldas Province, Ecuador. These mountains of northwestern Ecuador are part of the Chocó Forest, which is in turn part of the larger Tumbes-Chocó-Magdalena Bioregion, one of the world's biodiversity hotspots. The bioregion is bounded between the Andes mountain range and the Pacific Ocean and runs from the Panama Canal down to northwestern Peru (Dodson & Gentry, 1991; Mittermeier et al., 1999; Myers, 1988, 1990). The vast majority

[1] FEDETA is the acronym for Fundación Ecuatoriana de Tecnología Apropiada, or the Ecuadorian Foundation for Appropriate Technology in English.

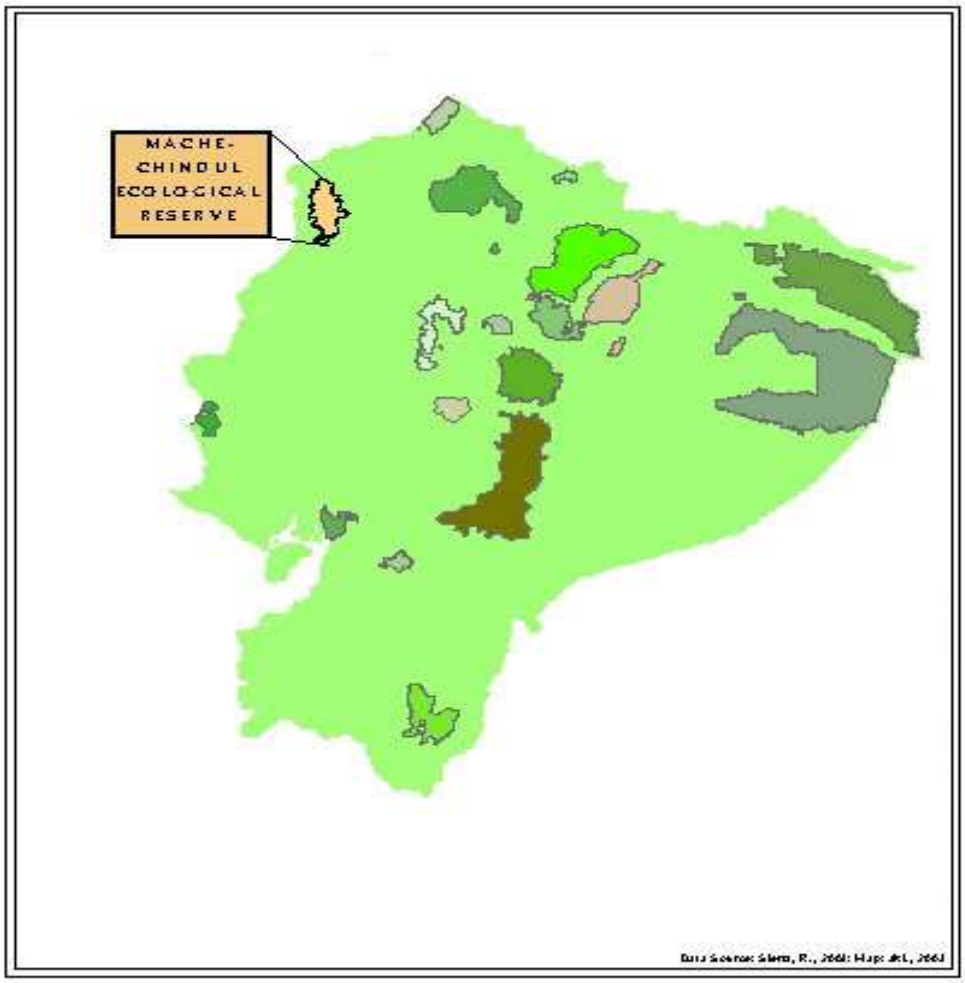

Illustration 1.1: Ecuador's protected areas with the Mache-Chindul Reserve highlighted.

(Fadiman, 2003, p. 23)

of the remaining Ecuadorian Chocó forest is in the northwestern province of Esmeraldas. This is due in part to the fact that Esmeraldas was relatively isolated from the rest of the country until the 1970s when road construction opened up the region to outside access (Dodson & Gentry, 1991). Due in great part to international pressure from environmental activists, Ecuador created the 111,000 hectare Mache-Chindul Ecological Reserve in 1996 in an attempt to preserve the remaining forest remnants (Fadiman, 2003). Las Balsas is located within the boundaries of the Mache-Chindul Reserve.

Culture

There are generally considered to be two groups of people living in and around the reserve. These are the colonists and the indigenous Chachi people. Approximately 7,600 indigenous Chachi live in Esmeraldas province, and although their history is not well documented, most researchers agree that they were originally from the highlands, living on the western slopes of the Andes. According to Chachi oral history they fled from either the Inca or the Spanish invasion. The colonists are comprised of mestizos (European and indigenous ancestry) and Afro-Ecuadorians. The latter comprise the majority of the population, and according to local mythology arrived in the region in 1553 when a slave ship wrecked off of the Esmeraldas coast.

The mestizos who live in the region migrated mostly from southern Ecuador. They first began to move in during the 1950s and 1960s searching for available land to farm as a result of land reform laws (Fadiman, 2003, 2005). The land reform laws allowed confiscation and redistribution to landless peasants any part of an hacienda that

included "unproductive" land. Consequently it became dangerous for an hacienda owner to retain natural forest since forested land was interpreted as unproductive and was subject to seizure. The land reform act also required total conversion to production activities of all forest on lands deeded to colonists. As a result of this law many haciendas in northwestern Ecuador were invaded by land-hungry colonists with the support of the land reform agency (Dodson & Gentry, 1991).

The current inhabitants of Las Balsas are mostly successors to the original colonists who arrived here looking for cheap land, hoping they could get a fresh start. Marcos is the oldest remaining settler in Las Balsas and he arrived around 35 years ago with his family, although his children have all since moved to urban areas for work. He moved here from far southern Ecuador after a series of failed jobs there left him unable to sufficiently provide for his family. Land there had become too expensive, whereas here he was able to acquire more than 70 hectares over the last three decades. When he arrived there were only three other families in the area, but many more have moved into the region in the intervening years.

Many have given up and moved on, but some have stayed, intent on carving out a life here. Rafael, 53, moved here from Manabí, the province just south of Esmeraldas, 23 years ago. He came with his wife and young son. His family owned no land where they came from, but here he owns 75 hectares. His father and several brothers also bought land in the area, but his brothers have since given up and moved out looking for better income. Another elderly couple moved here about 18 years ago after their children were all grown. The husband, Eduardo, had been a woodcutter all his life, and they had very

little land. Here they were able to buy 50 hectares with their savings. Several of the men told me that in the coffee-growing province of Santo Domingo to the southeast, a hectare of prime farmland will sell for 25 times more than a hectare of land within the reserve.

The main source of income in Las Balsas is from selling lumber, although two households reported that cacao had become their primary source of income. Most households cultivate at least small plots of cacao as their secondary income, although one household still relies solely on lumber harvesting. Since cacao in the region only produces fruit once a year due to chilly temperatures and high levels of rainfall, it is common for some entire households to occasionally migrate east for months at a time to work in the cacao plantations where day laborers can double their daily income. This was the main reason nine households were gone during my fieldwork. When they return they cultivate subsistence crops, tend their cacao plots, and harvest lumber for income.

In addition to their logging activities, most households grow some corn, rice, beans, and bananas. Their main source of local protein is fish from the river and meat from hunting guanta and wild pigs. Despite all these local food sources the community is far from self-sufficient in food production. Most households make a weekly or biweekly trip to the nearest town, a five-hour trip by walking or riding mules. The estimated 17 kilometer trip is often extremely difficult because the region's high amount of rainfall means that for most of the year the trails are very slippery and muddy. The food that households buy generally consists of things like rice, butter, onions, garlic, bread, and seasonings, as well as canned sardines and tuna.

Since no one in the immediate area is actively involved in reforesting, the remaining harvestable trees keep getting farther and farther from the river. This requires the lumberjacks to increasingly invest more time in transporting their lumber to the river, which greatly decreases profit margins. In addition to the increasing scarcity of lumber, since the region was included in the 1996 designation of the Mache-Chindul Reserve the ministry of environment has cracked down on "illegal" logging. One weekend I received word that the ministry of environment had confiscated over $20,000 worth of lumber at one of the receiving sites downriver.

No one from Las Balsas lost lumber in the raid, but they were all nervous about floating their lumber to market and waited a week or two before sending any more lumber downriver. As the Ecuadorian government struggles to appease environmentalists' efforts to preserve the fragmented Chocó forests, the isolated communities within the reserve's borders struggle not only with environmental depletion but also lack of basic infrastructure. They are caught between the need to feed their families and the international community's valuation of the surrounding forest. While they are technically allowed to live there, wholesale deforestation is legally prohibited, and no one in the community has land titles. Some of the settlers have fought for years to acquire official land titles to no avail. Marcos, the man who has been in Las Balsas the longest, thought he was close to acquiring a title to his land in the early 1990s, but after the creation of the reserve he was once again without hope.

Illustration 1.2: Logging, the primary source of income in Las Balsas.

Infrastructure in the region is minimal. The nearest electricity lines are a good two-hour hike downriver with no signs of advancing farther anytime soon. The nearest road that is accessible by vehicle is a five-hour walk downriver. Cell phone service is non-existent along the river bottoms where people live, although most households can reach service by hiking uphill for half an hour or more.

As mentioned, there were 11 inhabited households in Las Balsas during my research stay. I define household as any family or group of one or more people that lives together in the same house. The total population of Las Balsas over the summer was approximately 43 people. The number constantly fluctuates as young men come and go frequently, depending on when and where work is available. Out of the eighteen total children and teenagers, seven were in school, seven were teenagers, and the rest were young children. Since seventh grade is the highest offered, most children finish school around the beginning of their teenage years. Only two households had no children or teenagers living with them. The household with the most children had three children and three teenagers, but most households only had one or two children or teenagers. Several households had older children who no longer lived there because they had migrated out for work. All seven school students were taught by the same teacher. The teacher is a young man from another small rural community in the region.

Much of the community activity takes place near the community center. This area is located on a relatively flat area by a bend in the river and includes eight houses, only two of which were inhabited at the time of research; a small building, which was in the process of being reconstructed in order to serve as a church; a large community-center

building, the roof of which held the solar panels of the microgrid; a one-room school; a dirt volleyball court; and a grassy expanse used as a soccer field. This is also the area where the men meet to play pool. Most of the remaining homes are less than 20 minutes away by walking either upriver or downriver, however several homes are more than 40 minutes away by foot.

AUTHOR PERSPECTIVE AND METHODOLOGY

Author Perspective

I first became interested in solar PV panels as an undergraduate studying literature and writing. My girlfriend was a biochemist who won a summer grant to study solar PV systems. Through her studies I too became fascinated by solar PV technology. Once back on campus that fall semester we joined Solar Scholars, a group of mostly electrical engineers. I have a background in agriculture and construction, so I used those skills to help out where I could.

At that point in time the group was about to start work on designing a very small solar PV system to be installed on campus with the primary purpose that it would serve as an educational tool. During the following semesters the project expanded as we acquired more funding. Eventually we designed and installed, with the help of local contractors, a three-kilowatt PV system, which was approximately enough to power one computer lab. The solar PV system was located near to the campus museum so that visitors would get a tour of the system and its components, which were visibly displayed under a demonstration green roof.

After graduating college I served with the Peace Corps in the Dominican Republic in a community with no grid electricity. However, approximately a quarter of the community's houses had solar PV home systems. The community had first been introduced to solar panels about 20 years previously when a local NGO had provided some financing and technical support to electrify a number of houses. According to my neighbors, once the community was introduced to solar power anyone who could afford a solar home system bought one. Over the years more and more households got solar panels. Using what I had learned working with Solar Scholars, I installed a small solar home system in my house and occasionally provided technical help when neighbors experienced problems with their PV systems.

Previously to installing my solar PV system I had spent three months with no electricity. While I was able to carry my cell phone to neighbors to charge, access to my laptop was out of the question. I spent my evenings reading or chatting by the dim flickering light of a smelly kerosene lantern. Sometimes I visited households who had solar panels, and often groups of the nearest neighbors would be congregated there.

After the installation of my solar home system my life changed dramatically. With the solar panel I could now charge my cell phone when it needed it instead of waiting until I went to the neighbors. I also often charged cell phones for neighbors without solar panels. I could charge my laptop and finally work on project documents and even sometimes wile away the long evening hours watching movies. More importantly, it became clear that a well-lit house was a magnet for visitors. In the previous three months I had already noticed that in the evenings people tended to congregate at houses with

panels and light bulbs, either to chat or to watch movies if the PV system's batteries were well-charged.

Previously I had given much more thought to large-scale PV projects in the US, but during my Peace Corps service I became very interested in how even minimal access to electricity affects people's lives. As a result I became even more interested in PV technology than I had been before. The PV panels used in my Dominican community were all extremely small by US standards, usually around 50 watts, which meant you could not do much more than charge a few cell phones, charge a laptop, power a small radio, connect a few light bulbs, and connect a small TV screen occasionally. All households had to very carefully monitor their electricity use to avoid running out. Even so, during the overcast winter months almost all households only had minimal electricity access as there was not enough sunshine to keep the batteries sufficiently charged.

Community-wide, only a small amount of houses had solar PV panels. Thus when I learned about FEDETA's project, where they had installed much larger PV home systems in order to electrify an entire community, I wanted to study the impacts and see how different they were. Additionally, since all panels were installed during the same summer, change would be more obvious than in a community where solar panels were slowly acquired over a period of years.

Methodology

This research was done during five weeks that I spent in Las Balsas and the surrounding communities last summer. Although access to the community is often

difficult and there are no maps or signs, I was able to travel with the technician who provides inspections of the community's solar PV systems once every four months.

During the time that I was there I lived with community members, staying in several different houses and eating at many. I discussed my project with community members who all expressed interest in talking with me about their experiences with solar panels. I did not do any structured interviews, but rather I spent most of my days with the men out in the fields or the forest. I helped out on jobs where I could, but mostly I tagged along as the men cut lumber, went fishing, wild boar hunting, and corn harvesting. It was during breaks on work days or lengthy treks that most community members talked to me about their experience with electrification. I carried a notebook and jotted down notes from all my conversations.

Evenings I spent time with families for supper, conversation, and movies, after which I would spend several hours compiling my notes into a narrative about the day. One of my main reasons for being so informal was my past experience with development projects in the Dominican Republic. In my experience, when people are questioned formally by a researcher with a pen and large sheet of paper about a project of which they are the beneficiary their responses tend to be affected.[2]

In addition to asking many questions about their interactions with the PV systems, I also helped transport one of the solar home systems from one home to another. I then installed the PV system at a home that had initially opted out of the project because the homeowner had been skeptical. The homeowner at the original installation site was a

[2] All translations were done by the author.

young man who left to work in the east, did not plan on returning soon, and was not paying the ten-dollar monthly quota to the community treasurer, who then pays for the technician to check on the PV systems every four months.

By disassembling the system and reassembling all of the components at the new home I was able to get better acquainted with all the specific components. By spending time at different houses I was also able to observe how the solar home systems were used. One weakness in my research is that I did not get to spend as much time as I would have liked with women on a normal day in the home. Most days in which I spent the entire day at home were rainy days, and so some of the menfolk were also around. I would have needed more time in the community to establish the level of trust and understanding needed to spend more time in the kitchens.

I approached my field research relying on Vayda's (1983) idea of progressive contextualization in order to be able to respond to any unexpected uses or impacts of the solar panels. By trying to put aside previous assumptions I merely "followed the electricity" and focused on all activities that were affected by the project. Vayda's idea is that by starting with a focus on peoples' activities one can then follow the causes and effects of these activities outwards to connect with broader theories. I also followed the advice of Latour (2005) who advises researchers to "just describe the state of affairs at hand" (p. 144). And that is what I attempt to do. I essentially aim to describe in detail Las Balsas' "encounters with development" (Escobar, 2012). I study in detail the results

of this encounter, namely the installation of solar PV panels, between FEDETA, a development NGO, and Las Balsas, a rural subsistence-farming community.[3]

ENERGY ACCESS

> Like freedom from violence, hunger, and the disease of poverty, access to sufficient levels of energy must be understood as a cornerstone of human development.
> -The Breakthrough Institute (Roy, et al., 2014).

Access to energy has received a lot of attention in recent years. In 2011 the Secretary-General of the United Nations (UN), Ban Ki-Moon, launched a Sustainable Energy initiative that designated 2012 as the International Year of Sustainable Energy for All (UN, 2011). At the Rio+20 Summit, held in June 2012, more than 50 countries officially recognized the importance of energy access to development and made commitments to improving the worldwide energy access situation, although no binding commitments were made in regards to universal access to modern energy (International Energy Agency, 2012). In addition to being seen by the UN as a prerequisite for meeting the Millennium Development Goals, an adequate energy supply is also seen as being important in enabling access to communication technologies and a broad range of information (Gustavsson, 2008). So far no country has been able to greatly reduce poverty levels without substantially increasing access to energy services like electricity (Rao et al., 2009).

The UN's Sustainable Energy for All initiative has three stated objectives: to increase worldwide production of renewable energies, to improve energy efficiency in all

[3] The names of all community members have been changed to protect their privacy.

sectors, and to ensure universal access to modern energy services by 2030 (SE4All, 2013). As is typical of the UN, the goals are broad and rather unspecific. Given that nearly 1.3 billion people, around 20 percent of the world population, still have no electricity access (International Energy Agency, 2012), their goals seem rather lofty. Between the years 2000 and 2010 global demand for electricity increased by 40 percent, even though there was a small drop in 2009 due to the economic crisis. In addition, demand for electricity in the next two decades is expected to outstrip demands for other types of energy. Given these current trends some reports estimate that close to 1 billion people will still be without electricity by 2030 (International Energy Agency, 2012).

The 2012 World Energy Outlook report praises the Sustainable Energy Initiative for raising awareness about the "urgent need to increase modern energy access," but it points out that by the 2012 Rio+20 Summit only three percent of the required one-trillion-dollar investment had been committed (International Energy Agency, 2012, p. 529). The report makes clear that just providing universal electricity access will be difficult enough, let alone ensuring that it is from a renewable energy source. For those cringing at the possible spike in energy use associated with universal energy access, the report points out that extending electricity access to the entire world population would, at least for the time being, only increase global demand by one percent by 2030, and CO2 emissions by six-tenths of a percent. All in all this would be a very small relative increase in energy use. This is because those who would receive electricity do not currently have

Illustration 1.3: The solar panels of the PV microgrid in the Las Balsas community center can be seen on the building to the far left.

the capacity to use very much, even though that will not necessarily be the case in the long-term.

Yergin (2011) makes the case that the rapid rise in standards of living over the past century in large parts of the world has had almost everything to do with improvements in the harnessing of energy, primarily fossil fuels. Even today eighty percent of all world energy use is still based on fossil fuels. The Global North uses on average fourteen barrels of oil per person per year, while the Global South uses on average three barrels per person. The Global South's appetite for energy is predicted to grow enormously in the coming years.

What will happen when usage eventually triples in the Global South? As over a billion more people link into the globalized energy demand, fossil fuels may not handle the strain, and the environmental ramifications of huge amounts of increased pollution will be serious. Yergin (2011) points out that although the developed world takes electricity for granted, it absolutely cannot function without it. He argues that energy planners around the world need to make a concerted effort in moving out of the Fossil Fuel Age into a renewable energy future that is cleaner and more secure.

It is within this context that FEDETA works on addressing access to electricity in Ecuador. As of 2010 Ecuador's total electrification rate was approximately 92 percent, with only 77 percent of rural households having access to electricity. That leaves an estimated 1.1 million people without access to electricity services. In South America, only Bolivia and Peru have worse electrification rates, while the aggregate electrification rate across Latin America as a region is 94 percent (International Energy Agency, 2014).

While there are large swathes of the population in developing Asia and sub-Saharan Africa without electricity, in Latin America increasingly those without electricity are in extremely rural areas.

Small-scale renewable energy concepts are increasingly seen as a possibly effective way to serve the mostly-rural populations around the world still excluded from electricity access. In a similar way that many parts of the world have completely skipped landline phones and gone straight to cell phones, some envision rural areas building their own sustainable energy communities of the future and almost-completely bypassing the age of energy-dependence on fossil fuels (SE4All, 2013).

DEVELOPMENT PATHS

It is commonly accepted that the modern development era was born when Harry S. Truman, in his 1949 inaugural speech, used the term to refer to the countries in the Global South as "underdeveloped areas" (Escobar, 2012; Rist, 2008). Using the seemingly straightforward development logic developed by Rostow (1968), where development happens in neat, orderly stages, many looked towards a future where the entire world would eventually develop economically and share in the material and economic abundance of the US. Economic growth and increased consumption were seen as the inevitable and desired outcome of all development activities.

According to Sachs (2010), there are two types of development: one corresponds with economic growth, as measured in GDP, and the other corresponds more with rights and resources for the marginalized poor. Cowen and Shenton (1998) also distinguish

between two meanings of development: one is an "immanent and unintentional process," while the other is "an intentional activity" (p. 50). This distinction is essentially what Hart (2001) calls "big D" Development, which is the intentional intervention of the western powers in developing nations post-World War II, and "little d" development, which is the set of processes involved in "the development of capitalism as a geographically uneven, profoundly contradictory set of historical processes" (p. 650). Initially official government aid programs were the major players in development, and in fact still provide the majority of funding for development projects. In addition to government programs, NGOs proliferated across the globe in the 1980s and 1990s, many of them becoming providers of goods and services as a response to rampant neoliberal policies that dictated a reduction in government social services (Werker & Ahmed, 2008).

Since Truman's popularization of the term, "development has connoted at least one thing: to escape from the undignified condition called underdevelopment" (Esteva, 2010, p. 2). Development as seen by the citizens of wealthy nations is a profoundly positive thing,

> but for two-thirds of the people on earth, this positive meaning of the word 'development' . . . is a reminder of *what they are not*. It is a reminder of an undesirable, undignified condition. To escape from it, they need to be enslaved to others' experiences and dreams. (Esteva, 2010, p. 6; emphasis in the original).

Latouche (1993) puts it more bluntly: "The debate over the word 'development' is not merely a question of words. . . . One can't make development different from what it has been. Development has been and still is the Westernisation of the world" (p. 160). It is

this problem of development as a tool for hegemony and homogenization that has spurred some scholars to critique the entire idea of development and suggest that the whole paradigm is flawed. The promised bright side of development has too often been accompanied by massive displacements and dispossessions (Escobar, 2012; Latouche, 1993; Rist, 2008; Sachs, 2010).

In response to these negative impacts on communities, combined with increasing environmental devastation wrought in the name of development, the Brundtland Commission was formed in 1983. They group eventually released the now famous Brundtland Report in 1987, in which they coined the phrase "sustainable development" and called for traditional development practices to be reexamined in light of environmental impacts and unethical treatment of certain sectors of society (World Commission on Environment and Development, 1987). Over the years sustainable development thought has picked up steam and today is the predominant guiding ideology in development efforts.

Some scholars have developed a post-development theory that is meant to designate three things: the need to decenter development, to help make it possible to think about the end of development, and to transform the structure of expert knowledge and power in the development realm (see Escobar, 2012; Rahnema & Bawtree, 1997; Rist, 2008). One example of this could be the Buen Vivir movement in Latin America, where emphasis is put on quality of life, happiness, and environmental health instead of focusing only on economic growth. (Escobar, 2012; Gudynas, 2011).

For too long development has been seen as synonymous with economic growth, but increasingly it is becoming clear that this is not the case.

> There can be growth without development, and . . . there can also be development without growth. . . . The well-being of people who live on the lowest levels of the social pyramid can change for the better even in the absence of macroeconomic growth rates. (Stavenhagen, 2003, p. 5)

This is important for understanding FEDETA's goal in providing electrification to Las Balsas. FEDETA is following a recent development trend in focusing not only on the economic poverty of an area, but also on other deprivations like lack of health, education, and energy services, all of which result in low standards of living. The Multidimensional Poverty Index (MPI), first published in the UN's 2010 Human Development Report, attempts to measure deprivation factors like lack of education, low income, lack of access to health-care and education, and poor working conditions in order to compile a comprehensive standard of living at the individual level (UNDP, 2010).

Alkire & Santos (2013), key contributors to the MPI, point out that different households have different abilities when it comes to converting income to resources. Generally the more rural the household, the more difficult it is to come by resources like social services. Important needs like access to water, education, and electricity are often not met by the market. They argue that "income is merely a means to ends. It is the ends which are valuable, not the means" (p. 240). Following the ideas of Amartya Sen, Alkire (2007) argues that if we intend to understand development to "be the process of expanding the freedoms that people value and have reason to value" then we need to be

able to measure and understand just what these freedoms are (p. 348). Alkire and Santos are inspired by Sen's (2009) capability approach which basically shifts "the focus of attention from the *means* of living to the *actual opportunities* a person has" (p. 253, emphasis in original).

In this way capabilities are defined by what a specific person can achieve, thus expanding the possible freedoms enjoyed by those in question. In this view poverty is seen as the "deprivation of basic capabilities rather than merely as lowness of incomes" (Sen, 1999, p. 87). With this shift in focus from income to capabilities, different groups may register as poor. One group may be poor on the income scale, but have access to education and water, while another may not appear relatively poor solely based on income, yet may lack basic infrastructure. Community members of Las Balsas might be above the world's extreme poverty level in that their daily income is more than $1.25 a day, the level set by the World Bank, but they still lack access to many basic necessities like roads, convenient health services, and, until recently, full-service electricity.

The last decade has seen a distinct movement towards a more humanistic view of development that focuses more on individual quality of life. The qualitative nature of an idea like quality of life is intrinsically a much more difficult and less straightforward measurement than the quantitative measurement of income. One good starting definition is that "quality of life is understood in the sense of the possibility of satisfying basic needs" (Walsh, 2010, p. 16).

The emerging popularity of the Buen Vivir paradigm in Latin America is one way to understand this humanistic view. Buen Vivir comes from indigenous cosmologies and

is often translated as “living well” or “collective well-being.” Buen Vivir looks towards alternatives to development by focusing on quality of life and personal well-being within the context of community. Most articulations of the idea also extend to include the health of the environment.

The basic idea is about living “the good life”, which is of course a relative term depending on one’s personal or cultural definition. Gudynas (2011) argues that Buen Vivir should not be seen “as a mystical return to an indigenous past, lacking any practical strategy,” but rather as a plan which can help present specific guidelines and plans (p. 446). Buen Vivir still relies on Western physics and engineering but uses those resources in a more environmentally sustainable manner that focuses on local rather than global needs (Gudynas, 2011, p. 446). The ideas of Buen Vivir were first incorporated into Ecuador’s constitution in 2008 and then into Bolivia’s in 2009 (Gudynas, 2011).

Walsh (2010) notes the contradiction in that Buen Vivir actually originates in ancestral cosmologies that do not even have a term or concept for “development.” Increasingly, however, it seems that local development cannot be separated from global development.

Escobar’s (2012) visions of alternatives to development that promote “traditional cultures” instead of dominating them provide an interesting framework with which to visualize the future. According to Escobar, cultures can survive their engagements with modernity by hybridizing their cultures with specific beneficial technologies that still allow for levels of autonomy: “Out of hybrid or minority cultural situations might emerge

other ways of building economies, of dealing with basic needs, of coming together into social groups" (p. 225).

It is here that appropriate technology (AT) enters the picture, especially in the form of sustainable energy production. If energy has been important in the past, sustainable energy is becoming even more important. "Sustainable energy is the golden thread weaving together the three strands of sustainable development: the economy, equity, and the environment. It is essential for achieving the Millennium Development Goals" (SE4All, 2013).

APPROPRIATE TECHNOLOGY

AT has been touted as a key way to deal with issues of poverty, especially in rural parts of the developing world (Schumacher, 1973). AT has a long history of being utilized in attempts to address issues of poverty and health. The term as we know it today has its roots in the work of E. F. Schumacher, a German-born economist who moved to England as a young man. Disillusioned by what he saw as large-scale, rigid development projects, Schumacher introduced the term intermediate technology in his seminal 1973 book "Small Is Beautiful." The term was then modified to AT by later proponents of the idea (Schumacher, 2011). One of the earliest promoters of AT was Gandhi, although he did not use that term, in his work promoting small-scale industries utilizing the spinning wheel in rural villages in India (Akubue, 2000).

The core idea of AT is to challenge the assumption that all technologies are equally useful in all places, and to work on developing and implanting unique

technologies that are specifically tailored to the meet the needs of the population under consideration. Schumacher (1973) articulated and promoted the idea in order to attempt to address the widespread poverty in India which he believed to be a direct result of structural inequalities which were oppressing the rural poor.

AT has mostly been promoted and developed by NGOs working on addressing issues of poverty and health. As it is generally defined, AT is small-scale, locally managed, environmentally sustainable, and tailored to fit a community's needs. AT should be seen as more than just a broad range of technical devices: it is also an "approach to community development consisting of a body of knowledge, techniques, and an underlying philosophy" (Akubue, 2000, p. 37).

THESIS STRUCTURE

This thesis is divided into three additional chapters, plus a conclusion. In Chapter Two I provide a detailed description of the planning and installation of the solar PV project in Las Balsas. I then detail the specifications of the PV systems in order to contextualize how much electricity they produce. Additionally, I analyze the project's goals and aspirations, both from the perspective of FEDETA as well as from the members of Las Balsas. In Chapter Three I discuss how electricity has affected community life and relationships. I provide a comprehensive account of how the electricity is used and discuss the impacts for each respective use. In the fourth chapter I conduct a project evaluation. I evaluate the project from FEDETA's goal of improving quality of life. I consider how well the project fits into the AT paradigm. I also compare

PV home systems to grid electricity and look at what it means to a person's sense of dignity to have access to electricity. I conclude by analyzing the future of PV technology in rural development projects through the lens of what I have learned from the Las Balsas project.

Before I continue I must address here an issue of terminology. While I refer to Las Balsas as not having electricity before the installation of this project, some families did previously have gas-powered generators. However, in much the same way that we talk about being out of electricity during a storm, even though we might have access to a small backup generator, people from Las Balsas see a distinct switch from a time when they had zero-to-limited electricity access to now having an almost inexhaustible electricity supply. While they speak of the community as now having electricity (*luz*), previously some families had a generator (*planta*). In local parlance, to have a *planta* means to lug gasoline for hours upriver for only limited electricity. To say that the community has *luz* is to put it more on par with having access to grid electricity. By following this distinction in terminology I reflect the key distinction community members make between the two periods.

Chapter 2: Installation: Llegó la Luz

In late June of 2012, after months of planning and anticipation, the community of Las Balsas had access to electricity for the first time. Previously the community center had lain in darkness as soon as the sun slipped down over the western slopes of the Mache-Chindul mountains, but no longer. Lights were flicked on one by one in the small wood-boarded houses, and the community recreational field lit up in a warm yellow glow with enough light to be able to play soccer and volleyball as late as anyone had the energy.

The project had been under way for months, starting from the time when representatives from FEDETA mentioned that they were looking for projects at a mayoral meeting in the canton's main city of Musine. A representative of Las Balsas was present at the meeting, and after hearing about the project he introduced himself to the FEDETA representatives and invited them out to visit the community.

FEDETA was attracted by the fact that the community lay within the Mache Chindul ecological reserve. Having access to renewable energy so remotely far inside such a biological hotspot seemed like a sustainable development dream come true. In addition, the majority of the community members were excited about the project and showed commitment to carry it through. Thus the project was designed and carried to fruition.

INSTALLATION

The single biggest obstacle to the deployment of the project was transporting the materials into the community. Since there are no roads in the region, only foot and animal trails, the only option is to haul everything on foot, mule, or, when the river rises high enough, on a raft in the river. Community members estimate that it is approximately 17 kilometers of winding paths, mostly following the river or using the river as a path, from Las Balsas to the nearest point of vehicle access. The situation is complicated by the fact that since the region receives extremely high levels of rainfall, for much of the year the trails are difficult to travel because of treacherously muddy conditions.

The PV components that caused the most difficulty were the batteries and the panels due to their weight and fragility, respectively. Drawing on their skill at building rafts to float lumber downstream to market, community members constructed a raft at the port where they normally sell their lumber, loaded the raft with panels, and began the arduous task of slowly pulling it upriver against the current. This took several long and tiring days of slogging through deep water, pulling the heavy raft against the current. The batteries were also very problematic. Given the extremely high humidity and rainfall of the area heavy packs on animals tend to be abrasive on the hide. Since the batteries were bulky and could not conform to the shape of a mule's flank, many of the community's animals had large abrasions on their rear flanks by the time the last battery was hauled into Las Balsas.

Besides the transportation of materials, the only other main project component that was required from community members was to construct a structure large enough to

Illustration 2.1: Typical house with solar PV panels.

hold all of the panels for the PV microgrid system. Since most families already work with lumber and have constructed their own houses, it was relatively easy to source the wood and skills necessary for this building. FEDETA supplied the labor, materials, and expertise for the rest of the project.

PROJECT SPECIFICATIONS

The solar PV project consists of a total of eight solar PV home systems of three 128 watt 45.4 volt panels and one microgrid system of 72 of the same panels. The home-system panels are mounted on metal slats, which themselves are mounted on wooden posts sunk deep into the ground. The panels are wired in parallel to combine the total wattage, and the wires then lead into the house where they pass through a charge controller that reduces the voltage before charging the two connected batteries.

From the batteries the electricity passes through an inverter which converts the electricity from 24 volts of direct current to the most commonly used household electricity, 120 volts of alternating current. From here the wires are routed to normal household outlets and the switches that control energy-efficient light bulbs.

The PV home systems are fairly straightforward in terms of electrical wiring. However, a circuit breaker has been placed before each electrical component to ensure that current is interrupted in case of an overload or short circuit that could potentially damage the system. This extensive use of circuit breakers tends to make the system look much more complicated than it really is.

While the PV home systems are relatively uncomplicated, the size of the PV microgrid in the center of the community requires much more sophistication. The larger system uses basically all the same components, but the instruments required to handle the much larger flow of electricity, namely the inverters and charge controllers, necessarily become much more complex. Sporting an array of four columns of 18 panels each, the PV system looks much like something you would find on the rooftop of a wealthy suburban American home.

The microgrid is capable of producing 9 kilowatts per hour in peak sunlight on a clear day. How much is actually produced depends on the panels' angle to the sun, any shade covering them at certain hours of the day, as well as foggy or cloudy weather. For comparison's sake, I use an average of just under 5.5 kilowatts per day in my two-bedroom Austin apartment. According to the US Energy Information Administration an average US household used 30 kilowatts per day in 2012 (EIA, 2014). While this makes the microgrid seem small, it is really because of the massive amounts of electricity that Americans consume for heating and cooling large houses, as well as having an abundance of electrical appliances.

The microgrid is connected to nine individual houses, the school, the community center, and the public lighting around the community recreational area. Given the light usage per home the system is easily capable of providing electricity for 20 homes or more. However during my time there only three of the houses on the microgrid were inhabited as most people had migrated out for work. Among the eight houses connected to PV home systems, six were inhabited.

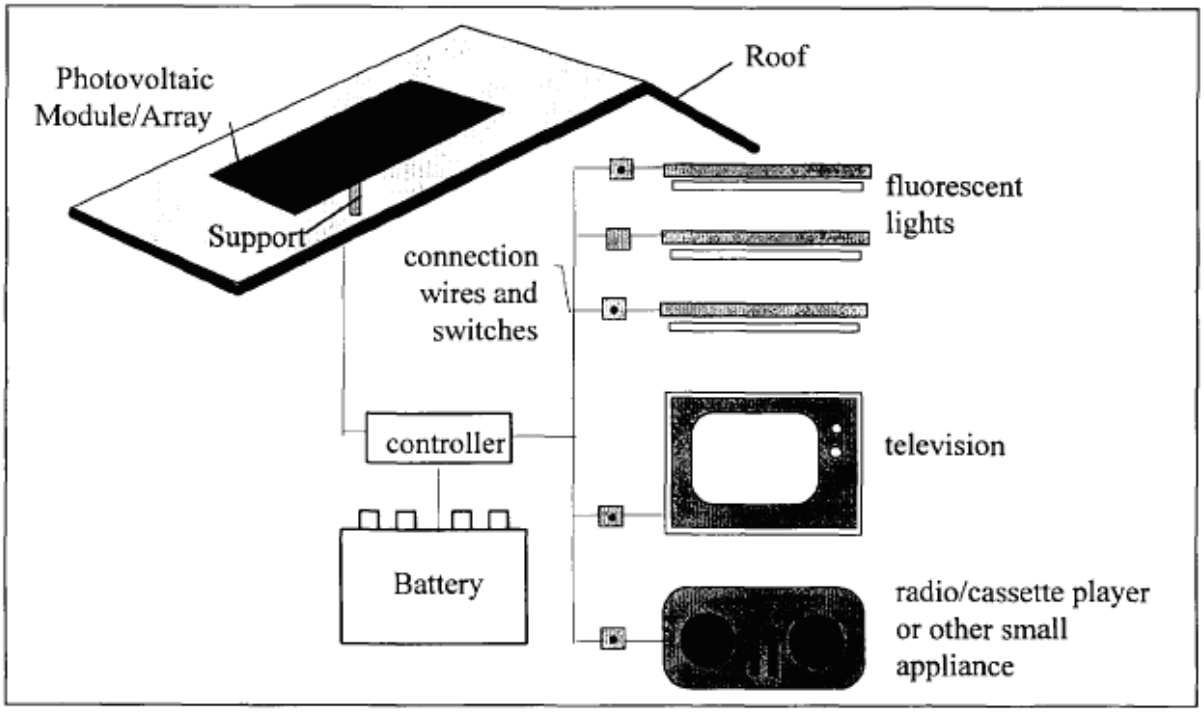

Illustration 2.2: Typical components of a solar PV home system.

(World Bank, 2008, p. 169)

PROJECT GOALS AND ASPIRATIONS

FEDETA's Goals

According to FEDETA's website, the organization's mission is the following: "FEDETA, through the generation, development, and application of scientific, technological, and humanistic knowledge, aims to achieve a world that is more socially just, more ecologically healthy, and technologically more humane." The website adds that this mission will be fulfilled by "providing energy solutions based on the use of clean energy."

FEDETA's specific goals for the Las Balsas electricity project, which I was told were to improve the quality of life of the community members, are deeply embedded in a larger energy access paradigm. FEDETA sees access to electricity as being key to helping people become more competitive and productive human beings. The World Bank, the UN, and others cite sufficient energy access as one of the main components necessary for meeting the Millennium Development goals (Bradbrook & Gardam, 2010; UN, 2004; UNDP, 2004, 2014a; UNDP et al., 2000). Energy access was not included as one of the Millennium Development Goals when they were introduced in 2000, and yet it is often acknowledged that sufficient access to energy is crucial to achieving each of them (International Energy Agency, 2012).

Given that the Millennium Development goals expire in 2015 it seems highly plausible, indeed some groups are busy advocating for this, that energy access will play a more important role in the updated and reformulated goals (International Energy Agency,

2011a). In the meantime the UN argues that there are no fundamental technical barriers to this goal, but rather that only political priorities and funding are lacking (UNDP, 2014b).

It is in this context that FEDETA was searching for rural communities that had no electricity access in the Esmeraldas province of Ecuador. According to community members FEDETA gave various workshops on how people could use the electricity. As it turns out attendees had differing memories about what the workshops from the previous summer had been about.

According to Diego, FEDETA talked a lot about income generation projects, but never did anything, besides providing the electricity, to invest in it: "You have to provide an initiative for the community. They [FEDETA] come and talk, but the community, each person returns to his house, sits down, and begins to think about the fact that tomorrow they have to go cut wood." Rafael said all that he remembers from the workshops is that they gave details on how PV panels work. Another elderly lady, Eduardo's wife, did remember some details about the workshops. When first asked she replied that the workshops were about proper use of the PV system, and that they had been given a workshop on "how to handle money," but she did not remember the specifics.

However, in a conversation a few hours later, after I had accompanied her up the steep hillside to where her husband was cleaning his cacao field in preparation for the upcoming harvest, she remembered some more about the workshops. She recalled that one of the workshops had encouraged them to work more with cacao. In the workshop they were apparently told how they could use their electricity to start a small cacao processing project. After detailing a list of all the machinery one would need, not to

mention the money to buy it, she concluded with a sigh by saying that even if you did manage to get all those other requirements together you still would not be able to get the products to market because of the lack of roads.

During our long conversation about possible income generation projects Diego remembered a video that was shown during one of the project's workshops. In the video there was a family who was barely making ends meet with what little money they earned from their one cow. They badly needed a new house, but just could not scrape together the resources to build one. Then one day disaster struck, and the cow got sick and died. Devastated the family searched desperately for new ways to make a living, and after some thought decided to plant potatoes. The first year they grew a bumper crop and so the following year they expanded their acreage. This happened year after year, and before long the now-happy family in the video built themselves a mansion with their new fortune. The moral of the story, as Diego pointed out to me, was what would have happened if that cow had never died.

For Diego the moral applied to the local lumber industry. He thought that maybe by giving up the illegal, and increasingly less profitable, deforestation, and by focusing on other enterprises, local farmers could possibly raise their incomes. But he was doubtful that they could do so without startup capital to invest in new projects: "What's missing in Las Balsas is money." Diego is echoing the microfinance mantra, which believes that the real obstacle facing the world's poor is the lack of access to credit (Collins et al., 2009) However this ideological model has increasingly come under fire for how it can actually lead to over indebtedness in rural areas by rushing to extend credit

without ensuring microfinance's contribution to income-generating activities (Hummel, 2013; Servet & Saiag, 2013) Additionally, this type of approach assumes that everyone is willing to be an entrepreneur, which is an unrealistic expectation given the relatively low percentage of entrepreneurs in any other society.

Even while Diego saw capital as the missing link to economic development, all the farmers and lumberjacks in the community did not necessarily agree. Some of them, like Eduardo's wife who I already quoted, saw the lack of roads as the key missing economic link.

FEDETA had specific goals for the impacts that they wanted to achieve through the implementation of the PV project. These goals are part of the organization's mission statement and are openly stated and articulated. When I asked community members why they had wanted electricity they looked at me like I was a child asking an overtly obvious question. It is clear that the people of Las Balsas in their hard work to help draw the project to their community each had some specific idea about what electricity meant to them, although it is not clear that these were necessarily the same goals that FEDETA had.

This ambiguity comes out of the fact that FEDETA's mission statement on their website, while not citing income generation specifically, mentions improving the productivity and competitiveness of beneficiaries. FEDETA acknowledged that due to lack of time and resources for this project, not to mention lack of local access to market, income generation was not the goal in installing this project. In fact, having income generation as the goal would have required a focus in the development of skills and

activities in areas of production. Notwithstanding their statement, significant members of the community remembered talks about income generation during project installation. Thus it seems that while income generation was not the principal aim of the project, it was included as a possible secondary goal by FEDETA.

Las Balsas' Goals and Perceptions

Earlier I detailed the extent to which community members worked in order to ensure that they fulfilled their part of the project. The community was not this involved from the beginning though. Community members informed me that they are generally very skeptical of outsiders' promises, as so many times over the years people have shown up promising projects but then have never returned. Many of the men told me that until the day that they saw the first shipment of the supplies arrive they did not really believe that the project would ever be completed, even after several visits to the community by FEDETA representatives.

This may in part explain their enthusiasm in making sure the supplies got transported upriver in whatever manner necessary. I was told that every household in Las Balsas that initially signed up to be part of the project received access to electricity. A few people did not sign up because they were wary of the monthly payments that would be required, and they deemed it unlikely that the project would ever work properly. They now wish they would have participated. The beneficiary of one of the solar home systems agreed to allow the community to move the solar system from his home to the home of someone who had not signed up initially. He agreed to this since not only was he not

making his monthly payments, he has been gone from the community for several months and currently has no plans to return since he has found work elsewhere. I dismantled and re-installed this solar home system at the new beneficiary's request about halfway through my research period. Another man who now wishes he had signed up is looking into the possibility of buying his own solar home system, although he does not think he can afford it. In his case he continues to use a generator whenever he needs electricity, whereas the man who recently received the solar PV system began spending significantly less time at his neighbors in the evenings after he had his own electricity supply.

Community members say they were very excited about the possibility of receiving electricity when they first heard about the project. When I asked them they never mentioned specifically why they had wanted electricity except in the abstract terms of saying that life is better now. When asked how life is better now they mostly referred to lighting and the comforts it provides in the early morning and evening hours. A few mentioned the entertainment value of movies and music.

Households are obviously quite fond of their solar PV systems. This is not surprising provided the physical comforts, such as illumination at night, and entertainment such as movies and music, that the electricity provides. Often on rainy days when a rare bit of sunlight broke through the clouds men would squint upward, look at each other and smile, and comment that the batteries should really be charging well.

Despite this, there is still a lot of misunderstanding of the solar panels on the part of community members. There is a disconnect between how users perceive their PV home systems and how the systems operate. Most people have a great fear of over-

discharging their batteries even though the system includes a safety switch that will cut all power if the batteries reach a dangerously low level. Granted this became more obvious during my stay as the region was experiencing a very heavy rainy season, and the dense cloud cover severely limited the amount of sunlight falling on the panels. My first impression was that they really were being overprotective, but I was not sure why. After some time there I realized that part of this overprotectiveness was from the fact that they did not have the technical experience, and much less the monetary means, to fix any of the components if they should fail. If something stopped working they would have to wait quite a long time as the technician only visits every four months.

One day while taking lunch break in the cacao field with his wife and me, Eduardo wiped the sweat from his brow in the afternoon humidity and asked me how long the solar panels will last. In response I asked them what they had been told. They replied that at the beginning of the project they had understood one or two years, but the latest that they had heard from someone else was twelve years. They did not seem to be too concerned either way, except that Eduardo commented that if the panels do manage to last twelve years grid electricity should have arrived by then.

Despite the improved quality of life, during the summer that I spent there almost half of the community had migrated out in search of work. While seasonal migration is somewhat common for certain families, in particular young males, everyone agreed that never before had this many community members been gone at once, even though this was the year just after they received electricity. While electricity may be improving the quality of life for those who choose to stay, or stay because they have no other option, it

is clearly not generating enough income to keep people from migrating out of the community. Perhaps this is one reason that people like Diego voiced their frustration about the fact that the electricity was not generating more income.

In their study of renewable energy markets across a broad range of developing countries, Martinot et al. (2002) find that "social benefits and quality of life, rather than income and economic benefits, have driven markets for renewable energy in rural areas" in developing countries (p. 328). If markets are driven by quality of life concerns, then it seems even more likely that beneficiaries of donor-funded projects will use their solar panels for the same reasons, especially since they do not have a monetary investment to recoup.

Diego told me that a few months after the installation of the project an associate of FEDETA's – not an employee, rather someone who had provided technical assistance on the project – came out to check up on the PV systems. The associate asked him how the community was utilizing their newly-acquired electricity. Had they started any income-generation projects, for example? Diego replied that no, there were no such projects and that the electricity was utilized to illuminate homes at night, to watch movies, listen to music, and to charge cell phones.

According to Diego this associate was not only deeply disappointed but got rather angry at the news. It is important to point out that this person was espousing personal views, not those of FEDETA. In remembering this occasion Diego himself got somewhat upset by his own perceived shortcomings of the project, namely that it had not provided access to capital, and said, "It makes me angry, because when this project arrived, it

brought nothing." Diego's statement is of course debatable depending on one's point of view on economic development versus humanistic development. I will address this concern in the following chapters. After detailing just exactly how the electricity from the PV systems is being used, I will look at how we can define success in a project such as this one.

Chapter 3: Utilization: Prende la Luz

USE OF PANELS

Light

While households in Las Balsas utilize their electricity from solar power for various purposes, the most frequent and common use is for lighting. It is the most basic use of electricity and does not require any purchases beyond light bulbs. The impact of lighting is perhaps the most advocated and most studied effect of electrification.

Of the nine homes currently utilizing the electricity, six previously had some access to a generator, meaning electric lighting was not something completely new. However the amount of electricity available, as well as ease and price of access, changed dramatically. Most houses have about five 13-watt energy efficient bulbs. Usually only two or three of these are on at a time, but the light is much more conducive to activity and social gatherings than candles or gas lamps.

Lighting was really the only electrical item that came with the project. FEDETA installed the solar panels and wired up the houses with light bulbs and electrical outlets. Several of the houses had already been partially wired up for light bulbs from the use of generators, so this in itself was not an entirely new phenomenon. However the old wiring was not used. Lighting by generator was much more limited than the 24/7 accessible light provided by the solar panels. Several households would only turn their generator on for an hour or two each evening when they had gasoline, whereas others rarely used theirs.

Whenever they ran out of gasoline they would have to revert to using candlelight or kerosene lamps, which is much inferior to the quality and brightness of electric light (Barnes & Floor, 1996).

I was told that about five years ago kerosene become impossible to find so that people were forced to start burning diesel fuel in their lanterns. Diesel is much less refined than kerosene and burns much dirtier, emitting a strong odor. Some people mix in a little gasoline so that it burns cleaner, but Rafael was uncomfortable doing that because of the danger of an explosion. There are plenty of hazards, both environmental and health-related, from using diesel or gasoline. The emissions, difficulty in transport, and spillage hazards are some of the more commonly mentioned problems (Gullberg, Ilskog, Katyega, & Kjellström, 2005; Nieuwenhout et al., 2000)

One man who used to fire up his generator most nights told me that he frequently used up to a gallon of gas on a long night. He calculates that he used five gallons of gasoline per week. With gasoline around $2.70 per gallon, plus adding in the price of oil, he calculated that he spent about $15 per week on gasoline. That is in addition to all the work required to lug the bulky gasoline containers upriver on mules.

When I asked him what he thought of the ten-dollar monthly user fee required from the PV project he responded, “Ten dollars a month is giving this electricity away for nothing.” Other households saw the monthly fee as more expensive. Householders who used their generators more frequently before the solar panel project were more positive about the monthly electricity fee than those who used their generators only frequently or had no generators at all.

All users agree that the electricity provided by the solar panels is much cleaner and easier to use than that provided by generators. The generators were often placed under the main floor of the house. A typical house has the main floor several feet above ground level to provide a dry storage space underneath, and the noise of the generator was disruptive. Also smoke from the exhaust would often drift up into house.

The same man quoted above mentioned how much he liked the instant access of solar electricity, no matter the time of day or night. If he has to go out to the latrine at night he does not have to hunt down his candle or flashlight, but can just flip a light switch. He particularly likes the easy access to light when he makes his Sunday trip out to town for supplies, as he often starts off around three or four o'clock in the morning. Previously he had to start up the generator, which woke up the entire family, in order to see to be able to saddle up his horse and the pack mules. Now he can just switch on the light, prepare for his trip, switch off the light again, and be on his way.

I saw a first-hand example of this one morning while staying with a different family. One morning I woke at four o'clock and walked out to use the bathroom. I was surprised that there was a light on in the kitchen. One of the teenage boys and a neighbor man were getting ready for a long day of steering lumber rafts downstream. In the warm glow of the light bulb dangling above the table they were quietly chatting while drinking coffee and enjoying the breakfast prepared them. There was no rumble of a generator and none of the under-illumination so prevalent with candles. The scene felt surprisingly modern and comfortable given the remote rural setting.

Change in schedule

One of the biggest reported impacts of lighting has been a change in the daily sleep schedule. The change in sleep patterns in Las Balsas was not extremely dramatic, and not everyone reported a change of sleep schedule, but most households did.

Some of those who did not report a change in their sleep schedule used a generator quite frequently before the installation of the solar panels. Yet others who used their generators frequently did report a change in their daily schedule. One older community member said that previously his family ate supper around five or six o'clock, shortly after finishing with work for the day. They then usually went to bed by seven or eight o'clock. Now, however, they usually eat supper around seven just as the sun is going down, and eventually make their way to bed between nine and ten. Their rising time has not changed. They still get up shortly after sunrise, around six. When asked, he said that they had soon became accustomed to the new sleep schedule and do not miss the extra sleep. If they have a hard day at work they go to bed early, but overall they do not notice a difference in getting less sleep.

Another young man also noted a difference in his household's daily schedule. He cited almost the same two-hour shift in supper and bedtime. In fact he and his wife frequently stay up until eleven. He admitted that on days when there is not much work to be done, or it is very rainy, they sometimes get up closer to eight o'clock rather than the normal hour of six.

Two families did not report any change in their daily schedule. The first still goes to bed by eight o'clock as they always have. According to the man of the house this is

because he has no radio or DVD player in the house. His sole use for the PV electricity is to power five light bulbs. His son, however, often goes to visit neighbors to watch movies at night, so he stays up later. The second household is an older couple who had a generator that they used practically every night previously. Just as they are accustomed, they eat supper around five or six, pop in a movie between seven and eight, and then retire after the movie.

Most people reported that they certainly did not mind that the nights were shorter since electrification. In fact, one man told me that previous to the PV installation he frequently woke up so early in the morning that he would lie awake for an hour or two waiting for the sun to rise until he had enough light to go feed his pigs and chickens and take care of other morning chores. This gentleman in particular was very excited about the evening socializing and entertainment opportunities made possible by the access to electricity.

This is perhaps not surprising in light of research done by Ekirch (2001) who finds that before the Industrial Age most people experienced an hour or so of wakefulness halfway through their night's sleep. Ekirch finds that beginning among the wealthier classes first, and slowly growing with the widespread use of gas lamps and later electric bulbs, this "segmented sleep" pattern slowly disappeared in many areas. Nowadays in our entertainment-rich non-stop cultures people tend to stay up much later than they would otherwise, and in some cases sleep is even disdained and seen as boring.

Gustavsson (2004) finds that in a study in Zambia, covering 400 homes which have solar PV home systems of 50-55 watts, 87 percent of households reported new daily

routines, mostly as a result of improved lighting. Additionally he reports that 64 percent say they have now extended work or study hours, while 27 percent say they now turn on the radio or TV. This is not unique to solar electricity. In Brazil the extension of electricity lines to the rural northeast led people to substitute their rural schedule for that of urban dwellers (Cardoso, Oliveira, & Silva, 2013). Whereas rural residents often went to sleep around 8:30 PM, now many do not retire for the night until the last telenovela is finished on TV several hours later.

Socializing

Electricity in Las Balsas definitely improves social life. Previously, Rafael regularly used his generator to play music and power a light bulb by a pool table that he keeps under a lean-to beside his house. This is the space where men and teenage boys hang out on the weekends. But they did not always have gas for the generator, and it occasionally broke down. The solar electricity has definitely improved weekend social gatherings. Now they have no noisy hum from the generator, making for a much more peaceful atmosphere. As one man said to me as we watched a game of pool, "Without music no one comes. Electricity always gets people's attention."

By dusk Saturday evening there is usually a rowdy game of pool going. Most often the womenfolk head into the house to chat or watch a movie while the children run amok, bounding up and down the stairs and playing in the yard. They have one single light bulb dangling over the pool table, and the music is often turned up loud enough to

drown out everything but the shouts of the children and the laughter of the pool players. The abundance of light thus allows for multiple social circles after dark.

The brightest lights in Las Balsas are the six pole lights at the four corners of the soccer field and on either side of the dirt volleyball court. This illuminates the entire area around the school and the community center where people most frequently gather. As Ekirch (2012) argues, when communal areas are lit up at night families are more likely to visit friends than to "cocoon" at home. I was told that when the weather is pleasant young people sometimes play soccer or volleyball until late in the night on the weekends. This did not happen during my stay, partly due to the high rainfall and partly due to the large number of people who had migrated out for work.

Kitchen / Appliances

Women tend to work all day in the kitchen, washing clothes, or in the field, but then must still prepare supper at the end of the day. Most times supper is consumed around dark, as daylight hours are utilized to the max in some sort of activity. Having a light bulb dramatically facilitates the women's work in the kitchen. While most households were hesitant to name any single age or gender as a principal beneficiary, generally replying that "we all benefit from the energy," one man said he thought that women benefitted the most because they have to cook in the evening. His wife added how much she likes that dishes do not have to be left for the following morning, stating that she often had to leave some cleanup until the following morning, but now she can do it whenever she wants.

Appliances can also make women's lives in the kitchen significantly easier. The most common appliance was a blender, and the households that had it used it frequently for soups and juices. Four households reported having blenders, but most households occasionally borrow from others. Refrigerators are a large potential benefit as well, although the PV home systems are not powerful enough to power a refrigerator all of the time.

Only two households have refrigerators. One is connected to the microgrid meaning that there is no shortage of electricity, especially since so few people are using the grid's electricity right now. The other family only connects their refrigerator occasionally and then only for a few hours at a time. They are very quick to unplug it if they see that the batteries are discharging. Their refrigerator gets utilized mostly after someone manages to bring in a wild pig or two, and then they use the refrigerator to help keep the meat fresh for a few extra days.

My interviews from the nearby community of La Colorada show that people do desire refrigerators. La Colorada is about a four-hour hike across the mountains from Las Balsas. About five years ago 24 houses there each received a small solar PV home system. Locals insisted that FEDETA installed the project, however a FEDETA representative said they were not involved. It remains unclear to me whether the project was done by a government agency or by an NGO.

The panels were only 100 watts which means they could power significantly less than those in Las Balsas. About one year ago grid electricity finally arrived in the community, and most people already have refrigerators. In fact one man told me that

several households even bought their refrigerators months before the grid electricity got there they were so excited.

In her research on Argentina, Pérez (2012) finds that refrigerators came to be part of the Peronist government's discourse of welfare democratization. Refrigerators and other appliances were represented in the press as essential to improving domestic comforts and thereby liberating the housewife from many petty household chores. Although refrigerators were initially conceived of mainly as luxurious status symbols in the 1930s, thanks to the democratization of home appliances, by the 1960s they were "considered essential to a family's assets" (Pérez, 2012, p. 165). Pérez shows how refrigerators went from being prominently displayed in Argentine living rooms to eventually being kept in more discreet places.

However, despite the change in "aesthetic criteria" the "model of domesticity" stayed the same, which was the achievement of comfort and a certain degree of liberation for the housewife (Pérez, 2012, p. 168). Through the creation of markets of mass consumption, refrigerators in Argentina ultimately came to be seen as necessary for a family's well-being. Studying the same period, Milanesio (2013) finds that refrigerators were the most desired of all electric appliances. Refrigerators were "the embodiment of well-being . . . [and] one of the highest material aspirations of low-income households" (p. 213).

In fact, Pérez (2012) argues that "consumerism provided a path to citizenship and a westernized lifestyle, which permitted the creation of new identities, new signs of distinction and a reorganization of social categories" amidst the many tumultuous social

transformations of the 20th century (p. 159). In a similar vein, Milanesio (2013) finds that many of the working masses remember how more affordable goods like refrigerators "transformed everyday life and broadened horizons" (p. 17). Refrigerators bestowed dignity upon a household, first through social status for the upper classes and later through becoming a prerequisite to a dignified modern life for the majority of the population.

It is a major drawback that solar PV home systems cannot power standard refrigerators. In a study on PV home systems in Zambia, Gustavsson (2004) finds that while almost all households reported that the arrival of solar PV power was a good thing, 70 percent of them stated they would rather have grid electricity. The main reasons cited were the additional electricity needed for cooking, refrigerators and freezers, and fans.

While in Las Balsas electricity from the PV systems is more reliable than the grid in nearby communities, the only people still regularly using their solar panels in La Colorada are those houses so remote from the community center that they are not connected to the grid. Although blackouts on the grid happen for several hours at a time, once or twice a week, previously the solar PV systems provided only minimal power throughout the day and only for two to three hours after dark. Now the panels are not used at all by those connected to the grid except as a backup during a grid blackout.

Entertainment

Everything was very sad here before. Now people play their music and movies.

Todo era muy triste aquí antes. Ahora la gente pone su música, su película.

- Las Balsas resident

Music

With a plentiful supply of electricity music is suddenly much more prevalent than before. Previously electricity was only available whenever a generator was running, and that was often only to power a movie or a light bulb for socializing at night. Most music was listened to at the community center on weekends. On those Friday and Saturday nights when he had gasoline, Rafael would start up his generator and then turn up the music on a stereo while the men played pool and the women and children convened in the house. Any rechargeable music player could not be charged at will, but only in those few hours of the day when a generator might be running. Disposable batteries were used for some devices, but they are not particularly affordable.

Teenagers are certainly the largest users of music. While few houses actually have large stereos, several of the teenagers, especially the boys, had small portable rechargeable music players. These are not designed to be listened to on earphones, but rather are small speakers with a flash drive insert for music storage. They often carry these with them as they head off to work in the fields, so that walking along the river you will often hear Aventura or Jimmy Gutierrez crooning long before anyone even comes into sight. Even among the young men who did not have speakers, almost all carried flash

Illustration 3.1: A teenager's portable music player

drives on which they stored their favorite music so as to be able to play it whenever they had access to a stereo. When they are in town they are able to acquire new music. For a few dollars, workers at internet cafes will load up customers' flash drives with the latest music from their favorite artists.

Perhaps the most creative use of the electricity has been by Carlos who owns land in Las Balsas but happens to live a bit farther downriver on a hill overlooking the center of another small community, which has no electricity access. A few years ago a brother of his brought out a mega stereo system from Quito. The box with speakers is about three-feet long and two-feet deep and high. This speaker box is roped up against the tin roof over one corner of his porch overlooking the valley below. The speakers are powered by a large amplifier which is itself run by an mp3 player music mixer. It appears to be something a DJ would use. Carlos said that he sometimes plays music on the system for a few hours on the weekends so that the community can enjoy it. Apparently you can hear it for half a mile or more up and down river.

At the bottom of the hill, a 20-minute walk away, is the community center, and there is a small roofed enclosure where locals stop to rest, chat, and maybe have a drink. Carlos has a microphone too, and occasionally when in a jolly mood he will wait until a horse and rider stop at the center and then, from the far distance of his house, will yell into the microphone for them to dismount and make themselves comfortable. Often enough, in about half an hour Carlos himself will come down on a mule to greet the person. According to another neighbor lady he will also sometimes yell into the

microphone in the early morning, shouting for everyone to get out of bed and get to work. The neighbors seemed to relish telling me tales of Carlos's use of his stereo.

Movies

My experience in Las Balsas shows that watching films comes second only to lighting, and perhaps charging cell phones. It became clear that most users value evening lighting and charging cell phones over watching movies. In an extremely cloudy week they might sacrifice watching a movie so as not to drain the batteries and still have enough power for light bulbs at night. However they certainly spend much of the energy and time related to energy use in watching movies.

Similar results have been found in other countries as well. Research from Thailand, China, Sri Lanka, Kenya, and Zimbabwe shows that there exists a strong relationship between solar electrification and the use of DVD players and TV (Greacen, 2004; Jacobson, 2007; Kapadia, 2004; Nieuwenhout et al., 2000). In Las Balsas only one family has access to television because of their location on a hilltop. Most homes are located in the valley along the river and given the remote mountainous terrain no signals enter there. Five homes, in addition to the one with television, had working DVD players during my stay.

While there is arguably some difference between television and movies, the point remains the same: solar electrification plays a great role in enabling rural inhabitants to access mass media. Besides, with the healthy black market in Ecuador, many TV shows end up for sale on DVDs in the street soon after they are aired on the legal channels. The

Illustration 3.2: Living room from where the family in this home watches movies on the DVD player located in the corner

main reason that people's evening schedules have changed post-electrification is the entertainment provided by movies. While those with generators and DVD players were able to watch movies before the solar PV installation, they watched far fewer movies. This had much to do with the limits of a generator, which needs fuel to run. Gasoline is expensive and difficult to transport upriver. As Roberto, who has no DVD player, said, "I still go to bed at eight because I have no entertainment." Now it seems many of the younger crowd can no longer really imagine living without movies.

One lazy Sunday afternoon while sitting and watching a long game of pool I chatted with Jorge, an 18-year-old with a wife and two small children, about his movie watching habits. Since so many of the families have currently migrated out of the community in search of work elsewhere, he has borrowed a DVD player from one of those families. Curious, I asked him what he would do if the family returned. I expected him to say that he will have to do without one for a while since they are so expensive, but his laughing reply was simple, "We'll have to buy one." His response shows that he does not consider having one as optional.

This is in contrast to another home where the DVD player was also broken. The father had bought a new player several months previously, only to have it be damaged when one of his inventive teenage sons sprayed it with large amounts of repellant in order to kill the cockroaches living inside it. This man also wanted a new DVD player but said that it would take him some time to save up the money to buy one. He borrowed one from neighbors whenever he could, but he argued that he could not justify buying one as long as his daughter needed new boots and he was not able to buy those for her. Although

it would take Jorge some time to save up the approximately 75 dollars needed for a new player, his attitude of "we'll have to buy one" was typical of the attitude of the younger generation. To approach to it as a luxury, to be bought only when absolutely affordable, was much more typical of the older generation.

The one family that manages to get TV receives two blurry channels from a homemade 20-foot bamboo pole with a wire running to the top where it connects to an actual TV antenna. The homeowner told me that he particularly likes watching mass on it. At seven o'clock on Sunday mornings he picks up a mass service out of Colombia, which he particularly enjoys because there is currently no church service held in Las Balsas. In addition he was amused by the difference between what he referred to as "Colombian mass" versus "Ecuadorian mass."

Most households watch a movie or a TV show (on DVD) almost every evening. Sometimes they will even watch two movies, but this tends to happen on special occasions, or when a group of young men get together. People do not only watch movies at night, however. One rainy afternoon the children of a family with whom I was staying had to shell a sack of corn for the chickens. They dragged the heavy sack of corn upstairs into the living room, brought a red bowl from the kitchen for the kernels, and formed a semicircle around the bowl facing the movie. Kernels dropped in the bowl, some plopping loudly on the wooden floor, as Burt Lancaster rode a brown stallion across the screen.

The movies are unsurprisingly an especial attraction for the children. They will frequently play music videos while doing household chores like sweeping the floor. One

day they had a DVD of music videos by Romeo Santos playing, and all the children had paused in their chores to watch a particular song. As they stood in front of the screen the father walked in from a hunting trip and exclaimed jokingly, “There they are, enslaved.” His manner of saying it showed he was delighted by their captivation as opposed to disliking it.

The interaction among movie watchers is quite fascinating. Unlike American viewers who tend to sit quite close to rather large screens, almost all of the people in Las Balsas sat quite distant from very small screens. They often lounge in hammocks and sit along the wall on benches made of planks 15 – 20 feet away from a 13-inch TV screen. Sometimes I could barely tell what was going on, but often if a neighbor was there who had seen it, or someone was just generally unclear about what was going on, an entire conversation would spring up about what was happening in the movie.

At first I was quite confused as to why everyone sat so far away from the screen. You clearly cannot see the details as well. As time went by however, and I saw how people used the films to interact with each other, it made more sense. Sitting close to the screen makes it harder to have a group interaction about what is happening on screen. Watching a movie in Las Balsas is (for the most part) very much a social activity and serves to help the community bond over shared interests.

The assumption is often made that watching TV or movies is a passive pastime, one in which viewers merely soak up whatever it is that they are watching. Morley (1992) argues however, that the media does not reach audiences in isolation, but rather that audience members “sift and compare messages from one place with those received from

another" in order to "respond actively and even argumentatively to the messages of the media" (p. 70). Jensen (1987) further elaborates on the idea that the reception of media cannot be automatically assumed from content emission, and that each audience will decode specific genres differently. According to Jensen, "if we are to understand the lived reality . . . we need to turn to the context of use, the physical setting where reception takes place, and ask, what is the meaning of TV viewing to the audience" (p. 25).

For example, Turner and Pertierra (2013) find that while most discussions of TV viewing in the US are filled with moral critique, in southern Mexico many families tend to "emphasize the positive value of educational television and documentary genres" and see no problem with children watching unlimited hours of TV and movies in the safety of the home (p. 88). Thus we see how the consumption of movies in Las Balsas may be interpreted differently and contain more complex meanings than what is apparent at first observation.

In American society it is easy to take television and movie access for granted, but it plays a major part in how we spend our days. According to the US Bureau of Labor Statistics (2013), in 2012 Americans over the age of 15 spent 2.58 hours per average weekday watching TV. This presumably does not include movies watched on DVDs or trips to the cinema. On weekends and holidays the number jumps to 3.42 hours. I was not able to compile accurate statistics on exactly how much time is spent watching movies in Las Balsas, and while it is certainly less than in the United States, it is clear that electrification has allowed locals to connect to a much greater degree with the world outside of their community.

Jacobson (2007) calls appliances such as television, radio, and cellphones "connective" appliances, showing that in Kenya "solar PV is closely linked to activities that help rural Kenyans to increase their interconnections with people, markets, and ideas in urban centers" (p. 155). As Gustavsson (2008) points out, the effects of energy services can be both positive and negative. Access to news can be educational, but access to TV and movies can also encroach on students' homework time. It is therefore important to remember that it is not the technology that determines the outcome, but rather how that technology is used.

There may also be unexpected outcomes from access to media like TV and movies. La Ferrara, Chong, and Duryea (2012) find that even after controlling for other variables, the presence of television in Brazil leads to a significantly lower level of fertility rates. They find that this effect is stronger in women of lower socioeconomic status, as well as in women who are in the later phases of childbearing. Notably the Brazilian government did not have an official population control policy for the time period studied. The authors find that "decreases in fertility were stronger in years immediately following novelas that portrayed messages of upward social mobility, consistent with the desire to conform with behavior that leads to positive life outcomes" (p. 3).

Television and lower birthrates have also been linked in India. Jensen and Oster (2009) find a direct link between the exposure to TV programs and lower fertility in women, as well as increased autonomy for women. They suggest this happens because "television exposes rural households to urban lifestyles, values, and behaviors that are

radically different from their own" and rural households' practices change as they adopt or emulate these new practices (p. 1091). While proper programs that provide access to birth control are also vitally important in fostering changes like those mentioned above, it is clear that mere access is not enough; people must want to take advantage of this access. These studies show how mere access to TV programming can affect communities' cultural practices.

Greene (2001) studies the introduction of cable television in the early 1990s to the small town of Pustunich, located in Mexico's Yucatan Peninsula. Previously the community had access to local television channels, but the switch to cable brought them global programming. Much like in Las Balsas, Greene (2001) finds that "television now forms a common audiovisual backdrop to many parts of daily practice" (p. 427). Not only is viewing TV a highly entertaining social activity, people often comment on what they have seen and imitate it. Stories from movies and telenovelas are later related to friends. In addition to providing this type of social entertainment, residents felt empowered by their increased knowledge of the world: "World news seemed to provide some town residents with a sense that they could evaluate their own position in the world in a more positive, informed, and objective way" (Greene, p. 427). Green writes that in addition to seeing TV as a model for cultural modernity, locals would quote TV as a source of authority. She posits that this dual combination of fun and seriousness makes TV a potentially powerful source of social change.

The impacts on women in Pustunich have been less significant than those cited in Brazil and India, but Greene (2001) notes that many more young women are choosing to

remain unmarried or opting for single motherhood, and that some of the rationale for these decisions is explained by referencing televisual stories. Greene argues that "local participation in Mexican telenovelas qualifies as an "everyday form of state formation" (p. 428), both through "positive constructions of nation identification" as well as through negative routes of collective oppositions to foreigners such as gringos (p. 429). She also finds that "TV creates a space for identity play within the household" (p. 421). While women mostly talked about "responses to family" during her interviews, they were much more open and expressed stronger opinions when talking about TV programs. Green also draws on the work of Gillespie (2002), who finds that "TV talk, though it may often seem esoteric and trivial, is an important form of self-narration and a major collective resource through which identifies are negotiated" (p. 205). Thus we see the subtle yet important ways in which TV and movies can shape local culture and identity.

Like Paluck (2009), who finds that a radio soap opera program in Rwanda was successful in intergroup conflict prevention, the authors of both the Brazilian and Indian studies cited above are motivated by the idea that media can be used to increase the beneficial impacts of development and health policies. La Ferrara et al. (2012) argue that television programs could be tailored to spread "important social and economic messages" to targeted local populations at a very low cost (p. 29).

Jensen and Oster (2009) are intrigued by the possibility that these types of results occur because of changes in the local population's norms and values, suggesting that this offers significant promise for TV as an economical way to pursue desired policy goals relating to gender rights, health, and education. While this same access to information has

some scholars warning that TV tends to serve merely as a propaganda or amusement machine (see Postman, 2006), Williams (2003) scoffs at the idea, arguing that people have always been exposed to and swayed by the ideas and actions of "masters, employers, judges, [and] priests," and that TV should not be seen any differently (p. 135).

Jenson and Oster (2009) cite various ethnographic and anthropological studies that show how in remote and rural areas television is often the primary manner in which households acquire information about the outside world (p. 1058). While this information may often be a skewed representation of reality, it is still arguably one representation of the world.

Following Jacobson's (2007) idea of connective technologies and the role that access to media can play, I studied the types of movies most commonly watched. The purchased movies are always pirated or copied versions of the original. Movies can be purchased in any of the coastal towns in the region for one dollar each. It has become popular to compress the media files and thus it is possible to put several movies on one disk. It is rare that someone can make the trip out to town and back in the same day, so trips there are quite infrequent. This means there are few chances to acquire new movies. To deal with this scarcity of new movies an informal neighborhood borrowing system has sprung up.

When I first asked about this, one older community member replied that households do not exchange many movies, but mostly just watch from their own collection of movies that they have acquired over the years. However I soon noticed that most households actually do exchange movies, it just happens very informally. For

example, sometimes in a lull in conversation, either at a pool game or at a work break in the field, a younger man will often turn to another and ask, “Seen any good movies lately?” If so, he will be questioned about the movie and whether he liked it. Sometimes it will be a new movie from a recent trip to town, but more often it will be an older movie from his collection that he had forgotten. Usually after listening to the plot of the movie the questioner will mention that he would like to watch it sometime, and sometime over the next few days they will exchange the movie.

Most people seemed to not be aware of how often they borrowed movies, or how often they never returned them. Most households had a box of movies, and as I leafed through them they would point out random ones that belonged to neighbors. The ability to lend and borrow freely certainly maximizes the enjoyment they can get out of one movie. While teenagers and young single men are certainly the main drivers behind this system of movie circulation, adults participate too. Teenagers however are more likely to be discussing the latest movie they have seen, as well as proactively showing up at others’ houses to borrow movies they want to see.

Popular movies include those starring Bruce Lee, Jackie Chan, and Van Damm. Foreign movies are always dubbed into Spanish. Popular telenovelas are “Destilando Amor” from Mexico and “Corazón Valiente,” produced in Miami. There is no censoring of movies from children, and as most movies watched are quite violent, children are exposed to a lot of brutal violence. This violence is often seen as comedic, not as tragic. It is not clear how much specific educational material the community watched, but as I showed in the discussion above, much can also be learned in non-educational media.

Education

While electricity has not revolutionized education in Las Balsas, it does play a crucial part in making education easier. Light bulbs are generally not used during classes except on very cloudy days. The role of electricity in education comes into play more in the area of homework. While children do most of their homework in the afternoons, they occasionally are too busy with chores, or they neglect their homework, so that they have to finish in the evenings. There were quite a few evenings where the children sat down at the kitchen table and spread out their notebooks to work.

As Jacobson (2007) points out, even though electric lighting can greatly facilitate homework in the evening, the availability of energy to do this also depends on having a PV system large enough to spare power for both illumination and entertainment. In his work in rural Kenya, he finds that in houses with PV systems smaller than 25 watts over half the energy is used for watching TV, while households with PV systems larger than 25 watts use the majority of their energy for lighting.

Thus having larger PV systems is important for the energy to be employed for multiple uses. Even though a larger system improves the amount of energy available for studying, it certainly does not guarantee it. “Intra-household dynamics” will still play a key role in how energy is allocated (Jacobson, 2007, p. 155). Gustavsson (2007) finds that while no evidence exists that children in homes with access to solar electricity in Zambia have improved their test scores, they certainly have increased the amount of time spent reading, and there are fewer complaints about the quality of light. In addition,

exposure to news outside of the rural communities through TV and radio can make "the outside world more real" (p. 1298).

Jensen and Oster (2009) provide evidence that the introduction of cable TV to rural areas of India increases the school enrollment of young children. While the reason is not clear, they connect this phenomenon with the improvement in women's status that results in them investing more in their children.

The second major influence of electricity on education in Las Balsas is the use of a computer. Shortly after the installation of the solar panels the teachers acquired a computer from the mayor of Muisne. Interestingly enough, several teachers in surrounding communities, with no electricity access, also received computers. I met one of these teachers one day to look at her computer as it had stopped working. She had plugged it in to an outlet powered by a generator, and by all appearances the fluctuating current from the generator damaged the computer. I later heard of one other teacher who did the same.

Operating a computer is generally not feasible on generators because the electricity supply fluctuates too much, but it is possible with solar panels. This allows Las Balsas to be the only community in the area where computer lessons are taught. Granted the teacher's computer skills are relatively limited, but he teaches afternoon classes to those teenagers who are no longer in school. Students typically only attend school through seventh grade. This gives students a chance to learn how to use a mouse, how to type, and how to navigate the basic mainframe of the computer. While this computer education is admittedly basic, Jacobson (2004) argues that solar PV technology's

connection to education links it, by extension, to rural-to-urban migration processes. A better education is usually crucial for social mobility in urban areas, and working knowledge of a computer may enhance employment prospects in urban areas, thus perhaps even influencing the likelihood of rural-to-urban migration in search of an improved source of income.

Income Generation

Although income generation was not by any means a primary goal of the project according to my communication with FEDETA, it does play a big role in the global discourse on solar-powered electrification in rural areas (Kapadia, 2004). Jacobson (2007) explains why NGOs and policy makers pay so much attention to income generation and electricity access:

> Income generation and productive uses of solar electricity have received a lot of attention in policy circles not so much because they are economically significant, but because they can—if present—serve as a powerful justification for international donor support for solar electrification. (p. 152)

Even so, literature surveys do not produce widespread evidence that rural incomes increase substantially following solar electrification (Martinot et al., 2002; Nieuwenhout et al., 2000).

Yet there are a few studies that find modest levels of income improvement. Jacobson (2004) finds that in Kenya income generation activities produced by solar electricity are present, but still less abundant than many solar advocates would like to

think. Income generation is certainly not a primary result of solar electrification in the county. He finds modest income generation activities in almost 50 percent of Kenyan homes utilizing solar power. Chakrabarti & Chakrabarti (2002) have also found that 46 percent of the people in a case study in India reported an increase in income as a result of expanded work hours from the introduction of solar power. Gustavsson (2008) reports that some people have used the opportunities provided by solar electricity to give private lessons or to open a small business in rural Zambia.

It is clear that "economic benefits from renewables are more likely in rural areas that are already undergoing development and can incorporate the additional energy dimension into existing development activities for water, health, education, agriculture, and entrepreneurship" (Martinot et al., 2002, p. 328.) According to FEDETA, the reason they did not aim for income generation was because they knew that actual activities and training were needed, not to mention that one of the main difficulties facing any income-generation project is access to a market. However, as I showed above, this does not mean that some beneficiaries do not desire to use the electricity for income generation.

Despite FEDETA's statement that income generation was not a project goal, I discovered that one household was using the electricity directly for income generation purposes. While the total amount of income that the project will potentially generate may not seem like much, it is worth looking at this household's practices in detail in order to understand how what may seem like small improvements in income can make large impacts.

When I talked to him, Carlos had just recently built a small shed where he is raising meat chickens. I talked to him on July 4, and he had brought his chicks upriver on June 17. He bought the day-old chicks in Atacames, over two hours by bus from the local town. He started out with 40 chicks that cost him 85 cents each. He buys a balanced feed mix, consisting of corn and vitamins, to feed them. The feed mix is rather expensive, costing him 28 dollars per 100 pounds, but he calculates that this is worth the investment as they grow a lot faster than if just fed cracked-corn kernels from his own supply.

According to current market prices he plans on being able to sell the chicks in the nearest town for one $1.40 a pound with the feathers and intestines removed, or for $1.25 a pound with the complete body. He has a friend not too far downriver that has been raising chicks for almost a year now, and she has been reporting good profits. That particular lady saved up money from Ecuador's conditional cash transfer program to get started. She always find buyers for the chickens at slaughter time, if not in the nearest town, then in one of the relatively nearby coastal towns.

This lady however does not have any electricity access so she burns diesel in kerosene heaters to keep the chicks warm. Not only does this require a lot of extra work in hauling the diesel upriver, it also burns so uncleanly that the chicks get completely black from the fumes as they huddle near the heat. Carlos did not seem to think that he would want to eat those chickens.

For his chicks Carlos has installed a single light bulb, which he leaves on all of the time, hanging it down close to the floor so that the chicks can huddle near it. He keeps the light bulb there both for the small amount of warmth it gives as well as to keep the

Illustration 3.3: Using the electricity to raise chickens.

chicks eating day and night. As of the date of my interview Carlos reported that he had spent 56 dollars on the chicks so far, which includes some antibiotics and other medicines.

In addition he calculates that he will have spent 90 dollars in feed by the time the chicks are fat enough for market. That will be the majority of his expenses. If he can sell them at 5 pounds each, with the feathers and insides removed, he will gross 250 dollars, leaving him with a net return of 104 dollars. This is of course assuming no losses, which is unlikely. Spread over the approximate five weeks it takes to raise these chicks, in a best case scenario that is almost three dollars of profit per day. This is arguably not a bad return for the few minutes per day spent on caring for the chickens when a day laborer in the region earns ten dollars for a day's work.

So far he has not lost any chicks. In fact, since he loses so many of the chicks born to the layer hens running around his property to the cold rains and mud, he has started putting them in the chicken shed as well. This is an extra bonus as he gets to build up his flock of layer hens much more rapidly. I asked him what had made him decide to raise chickens, as none of the other households had attempted anything similar. He replied that he had wanted to do this for quite some time since his neighbor was so successful, and now that he has so much extra electricity all of the time he decided to give it a try. He had not wanted to use diesel-burning heaters for light like his neighbor, but knowing that he had access to plenty of electricity gave him the impetus to gather the lumber, construct a shed, and invest in some chicks.

Although there are not many income generating projects happening yet, there are possibilities. Fish-farming is one. I saw a tilapia pond downriver near where the electricity lines end. With plenty of fresh river water in the area, all that is needed is a pump and the electricity to power it. Las Balsas community members stated that they do not have the capital to invest in such a project even though they now have the electrical power. There is a lot of *tagua*, also known as vegetable ivory, in the region, which is a hard seed commonly used in artisanal crafts and jewelry. The teacher at the school knows how to make artisanal crafts and dreams of opening a workshop, but says he requires funding for equipment. Other more indirect income generation results are the ability to charge cell phones more easily in order to communicate with potential buyers of cacao or lumber. While not a direct result, cell phones that allow the ability to communicate with people in market areas certainly are one connective technology that can help to improve income.

Chapter 4: Discussion

QUALITY OF LIFE

FEDETA made it clear that the goal for the project was to "improve the quality of life" (*mejorar la calidad de vida*) of the community of Las Balsas. Most of the electricity is used for "cultural energy services" which result in a general improvement in living standards that should be seen as "part of the human capital of the livelihood assets" (Gustavsson, 2008, p. 77). As Jacobson (2007) points out from his work in Kenya,

> while solar electrification is frequently framed using neo-populist style arguments, the policies, practices, and social outcomes associated with solar PV in Kenya are more closely associated with the neo-liberal idea that poverty alleviation is best achieved through the integration of poor people into world economic markets. (p. 146)

In other words, development is often equated with economic growth. And yet, as mentioned in Chapter One, it is possible for people's well-being to improve even when there is no macroeconomic growth (Stavenhagen, 2003). One problem is that while monetary income is relatively easy to measure, measuring quality of life is a much more fraught undertaking.

It begins with the question of what is needed to have a good quality of life. While we can all agree that certain things like food and water are basic needs, there is still some debate as to whether electricity is a basic need. Should electricity access be seen as a basic need or just a luxury item, available to those who can afford it? Some authors argue

that access to energy should be framed in terms of human rights (Bradbrook & Gardam, 2006, 2010; Tully, 2005, 2006). Unless energy access is framed in terms of rights, many NGO's may have a hard time selling "quality of life" projects to donors. Unless quality of life can also be defined by measurable improvements in areas like health and education, it can be hard to sell. Gustavsson (2008) points out that it is unlikely that NGOS will fund solar projects to watch martial arts movies, but studies that show that health and education are improved by the introduction of electricity will have a different impact. As I have shown in Chapter Three, the impacts of telenovelas and other TV programs can be far-reaching.

As I explained in the introduction, many organizations like the World Bank and the UN argue that expanded access to energy, specifically electricity, will be crucial to meeting the Millennium Development goals. Much of the current literature on solar home systems is focused on the market-based expansion of solar PV products. Yet Jacobson (2004) insists that some sort of subsidies will be crucial in providing electricity within the next few decades to those 1.3 billion people still lacking access.

Even so, heavy subsidization of services has not always correlated with improved results. Decades of goods and services delivered by thousands of NGOs has arguably still not dramatically fixed the problems of the world. Malhotra (2000) even goes so far as to call the NGOs that provide social safety-net programs part of a "global soup kitchen," meaning they merely alleviate today's pains, but do nothing to fix the root of the underlying social and economic inequalities. It is often difficult to distinguish between programs that sustainably improve quality of life from programs that are a mere

pacification of the poor to keep them placated in what is essentially an unequitable social structure.

Malhotra (2000) wants NGO-client relations to move beyond their current heavy focus on aid, arguing that doing so will increase the likelihood of successfully reaching the ultimate goals of social justice and poverty eradication. Bebbington, Hickey, and Mitlin (2008) argue that NGOs need to move toward more politically activist work, insisting that just because governments shirk their duties does not make it the responsibility of NGOs to pick up the slack. The authors realize that these same NGOs will be criticized from the other side for not properly helping the poor, and for ignoring the lack of basic necessities like potable water, for example. Still, they want NGOs to work at publicly shaming governments instead of just filling in for them. They argue that these service problems are actually the responsibilities of governments anyway, and NGOs actually undermine the state's long term role by letting the governments off so easily.

On the other hand, Banerjee and Duflo (2011) argue that even though there is some truth to the fact that foreign aid is sometimes problematic for long-term local development, this actually has very little practical meaning in how the lives of the world's poor are currently lived. In other words, the poor are never consulted about these ideas, either for advice or to see how it may actually be impacting their lives. Reflecting on his years working in the development field, Hulme (2008) states that over time he has become much less concerned about the fact that NGOs may be undermining the public sector. He argues that there is actually plenty of demand for the types of social services

provided by NGOs, so much so in fact that even the public and private sectors together would struggle to meet the need. This brings us back to Jacobson's (2004) argument that extensive subsidies are needed to meet the electrification goals set by groups like the UN and the World Bank (SE4All, 2013).

In fact, most energy services in most countries are already heavily subsidized. The International Energy Agency (2011b) estimates that in 2010 global subsidies on fossil-fuel derived electricity totaled well over 100 billion dollars. Additionally, only nine percent of those subsidies were received by the income group in the bottom 20 percent. In 2012, the average subsidization rate of any fossil-fuel consumption in Ecuador, whether for electricity or otherwise, was 51.5 percent of the supply cost (International Energy Agency, 2013).

The two development critiques I presented do raise valid questions as to the role of solar PV energy projects like those provided by FEDETA, and their validity in constructing sustainable long-term development projects. Specifically I would like to ask if the PV project in Las Balsas falls prey either to Malhotra's (2000) critique that NGOs are merely part of a global soup kitchen, or to the critique of Bebbington et al. (2008) that NGOs undermine the state when they provide services that the state cannot or will not provide. I argue that it does not. Paternalism is a risk in any aid project, and I see no reason why the energy provision sector is any more susceptible to this than any other sector.

While the Las Balsas project does require the initial investment of outsiders, the locals are responsible for continuing to pay for the continued upkeep of the system.

While this presents its own problems, I deal with this in Chapter Two. Providing access to electricity does more than just meet today's energy needs, it builds human capital that makes beneficiaries more connected and involved with society. Additionally, it is not clear that solar home systems slow the spread of electrification projects by the state. Given that most users still prefer grid electricity if given the chance, solar PV technology manages to fill an interim demand.

APPROPRIATE TECHNOLOGY EVALUATION

The one problem with solar PV power is that it is still quite expensive and relatively technologically advanced. Even in wealthy countries like the United States solar PV systems are relatively complex, and this only becomes more so in rural Ecuador. According to Schumacher's (1973) original conception, AT is something that one can repair locally. I would not go so far as to say that one should be able to afford it, however once a technology is installed it should be locally manageable.

In Las Balsas the components are still quite new which means few parts have failed. But locals are keenly aware of the fact that they cannot afford to replace any parts if they break. The monthly fees paid by members ideally will go towards repairs, however a significant chunk of that currently goes towards paying for the services of a technician who visits every four months to ensure that everything is running smoothly.

FEDETA is essentially removed from the project as their donations basically covered only the installation. Personally I am concerned about the project within five years. Although the community is saving money from the quotas, it is likely that most of

the batteries will need replaced around the same time, and there is no way they will have enough money to replace them all without outside assistance. At a community meeting this very point came up. Community members were worried that those who potentially abuse their batteries will need batteries sooner. What happens if they empty out the community savings account and then sometime later several more people need batteries? They have no long term management plan for this, and this is certainly one of the reasons that many attempt to take such good care of their PV systems. They are just hoping they last as long as possible, or in the words of one community member, that they last until grid electricity arrives.

From the beginning many proponents saw AT as a process in which lower-income countries could improve their capacities, as opposed to seeing it merely in terms of "technology transfer." However, as Dudley (2002) points out, that realization has remained elusive, and instead we have seen that AT projects are "frequently dependent on the presence of an enthusiastic champion; the field worker who ensures technical back-up and cajoles the 'beneficiaries' into using the product" (p. 6). In cases relating to technology transfer, the fact that the poor lack capital, influence, and specific education will tend to create an environment in which the new technology is not appropriate. The risk is that technology projects only work as long as outside assistance, in the form of money, technical assistance, etc., continues, but as soon as the donor organization withdraws the technology may fall flat (Gustavsson, 2008).

My intention is not to get into an esoteric discussion of the definition of AT, but rather to question how much of an appropriate technology the solar PV systems are in the

context of Las Balsas. I believe it is important to make a distinction between the home systems and the microgrid. With my past experience working with PV systems I found the home systems to be pretty straightforward to work with. In addition, the main components are small enough that they can be relatively easily replaced if the funding is present. In this sense the solar home systems are quite manageable, and it is possible to replace the components if necessary. While batteries tend to be the first component needing replacement, their replacement is conceivably feasible.

In the microgrid, while the setup is the same, many of the components are necessarily much more complicated. Size-wise the home systems do a great job in covering the households' electricity needs, outside that of a refrigerator. The microgrid produces much more power than that which is used. Even in a succession of cloudy days the power level in the batteries barely dips. Granted several households have currently migrated out for work, but if the system were to provide the same amount of electricity per household as the home systems do, it could easily power 20 households, more than twice as many as the entire community. The microgrid however is sufficiently complicated that if any parts fail, aside from the solar panels, it seems likely that the entire system will be left not working. AT has always been about scale, and between these PV systems I see a distinct difference in scale.

As we saw in previous studies, very small systems tend to get used mainly for entertainment and very little else, thus FEDETA can hardly be faulted for attempting to ensure a plentiful supply of electricity. According to locals, everyone anticipated that more people might move into the center after the electrification project, but that has not

happened. The arrival of electricity also has not reduced the number of families who migrate out for seasonal work. So while the PV technology has improved the quality of life for those who stay, it has apparently not raised it enough to satisfy the demands of a significant part of the community.

THE GRID VERSUS SOLAR HOME SYSTEMS

A decentralized energy system makes a lot of sense, both for energy security and reliability; however autonomous, stand-alone systems, like many technology-based development projects, only work if and when proper technical help is available (Dudley, 2002). Las Balsas is in a unique situation in that they are in an ecological reserve and therefore grid installation is potentially more problematic than some other areas. While grid infrastructure may be seen as opening the way to more environmental destruction in the area, this is not necessarily the case.

During my field research electricity lines were in the process of being installed in Guayacan, the only other community in the area as distant from the western side of the reserve as Las Balsas. Guayacan is situated along another river about a three-hour hike to the north of Las Balsas. Walking along the riverbank the infrastructure of the grid electricity is not very noticeable. While some trees and other vegetation have been removed to clear the lines, as of yet it has not been the forerunner of any kind of road.

Until a cheap and long-lasting energy-storage solution can be provided, grid connection is still the best option for most rural communities. Some communities may be so distant that this is simply too cost prohibitive, but where possible, this will provide the

best quality of electricity to consumers. While much of the literature argues for the positive side of autonomous electricity microgrids, the problem is being able to locally manage that microgrid. While blackouts can be very common in many developing countries, grid access at least ensures a more affordable long-term plan to electricity access.

The plan developed by the Rocky Mountain Institute to expand the United States' economy while simultaneously dramatically reducing dependence on oil is based in great part on a more comprehensive, unified grid network (Lovins, 2011). When a community is off-grid they shoulder the entire responsibility of their electricity supply. While this sounds great in terms of autonomy, it is actually cumbersome, expensive, and cost prohibitive. The best option for governments in these situations is to connect their population to a national grid whenever possible. In some cases this will be extremely expensive and impractical, and there PV microgrids can be installed.

Although the World Bank's sustainable-energy-for-all program envisions communities with microgrids skipping the oil-age completely, it is not clear that this is a realistic or desirable dream. Currently the big problem in all PV systems is storage, and having a grid to which you can feed your extra energy during peak hours is actually a lot more sustainable than being isolated from the system and not using all of your possible energy.

As I mentioned earlier, Jacobson (2004) argues that a key issue needing to be resolved around electricity access is whether it should be treated as an entitlement to everyone, or if it is indeed a commodity that will only be available to those rich enough

to afford it. According to him the emergence of market-based solar electrification has been a result of the neoliberal privatization and restructuring processes seen in many developing countries in the past few decades. Given that solar PV installation is generally much cheaper per household than grid electrification in rural areas, this has allowed for at least some unsubsidized rural electrification in Kenya and other countries.

This movement is part of a broader shift that tends to treat electricity more like a commodity, available only to those who have the means to pay for it, and less of an entitlement as a citizen of that specific country. This varies from country to country. According to Jacobson (2004), in Kenya the common view seems to be that at least those who can get solar PV should, because the rest are unlikely to get electricity anyway. The real problem then lies in the fact that the trend towards unsubsidized electrification does not grant (even the promise of) access to the low income population any time in the near future.

In South Africa many of the solar home systems that were installed to make up for lack of grid access soon quit functioning because of lack of access to affordable parts and technical expertise (Annecke, 2002). Annecke (2002) argues that "renewables in the form of [solar home systems] for the rural poor do not address the fundamental problem of energy for sustainable development" (p. 14). Her point is that while solar technology can significantly improve quality of life, as I have demonstrated in this thesis, it still does not provide enough energy to cook with. In lieu of petroleum gas or electricity people will cook with wood which can be a major contributor to health problems, deforestation, local environment degradation, and global warming.

In Las Balsas the majority of families reported that they cooked most of the time using petroleum gas. However those with large families still used wood almost exclusively, and even others did quite a lot of cooking with wood during the time their petroleum gas tank was empty, either because they could not afford to fill it or rain had made the trail impassable.

Ecuador's petroleum gas is heavily subsidized, and consumers pay about 11 percent of what the gas would cost at world market prices (Sánchez, 2013). For this reason president Rafael Correa announced last year that starting in 2016 consumers will have to pay market prices for petroleum gas. In the meantime the country is working to phase out gas stoves for electric ones, the extra electricity being provided mostly by eight giant new hydroelectric dams (Araujo & Montero, 2013). This was a topic of serious concern to people in Las Balsas, who were worried that there would be no provisions for those one million Ecuadorians like themselves who have no access to grid electricity. This is reminiscent of Annecke's (2002) point that if organizations like the UN and World Bank are really serious about getting renewable energy to everyone they will need to address the issue of energy use in cooking, which is something grid electricity can take care of, but solar home systems still cannot.

While a grid connection will provide a stronger energy supply than a small PV system, this is not to say it resolves the issues around energy fomenting economic development. Brazil's Luz para Todos program aims to bring grid electricity to rural areas lacking access, with the specific assumption that this will foster not only social but economic development. In one community studied, 85 percent of people stated that one

year after the installation of the grid local incomes had not risen, and a majority were still considering leaving the area in search of a better income (Cardoso et al., 2013). As such, the authors recommend that the Luz para Todos program be integrated with other social programs, such as Brazil's Bolsa Familia, a conditional cash transfer program. They argue that governments and organizations must be aware that regional problems like lack of access to electricity are not isolated issues, and only an integrated approach can hope to significantly improve both income and quality of life over the long-term.

CULTURAL CONSUMPTION

In Chapter Three I discussed the strong link between solar electrification and TV that has been found in studies in various countries. Jacobson (2004) sees a strong link between solar electrification and the expansion of markets for consumer goods. He adds that although this same connection can be seen with grid electrification, grid electricity usually provides for plenty of power in addition to radio and TV use. Since most PV systems do not power much besides those applications, this area tends to get a lot of focus.

Hart & Prahalad (2002) argue for a more "inclusive capitalism" through focusing the market on the world's poorest citizens. Their idea is that through tailoring products and services to this group's lifestyles, those less fortunate can also find prosperous opportunities in the same capitalism that has excluded them for so long. My research, like Jacobson's (2004), suggests that this "inclusion" comes more in the form of immersion

into the markets of consumer goods than it does in the form of immersion into a monetarily profitable capitalism.

> While solar PV systems may provide power for TV sets that allow business advertisers to encourage the purchase of consumer goods, they appear to play a smaller role in supporting activities related to generating the income required to participate in those markets. (p. 293)

Jacobson's research shows that solar PV systems, at least when bought through the private sector, "are purchased more as a consumer good than as a productive investment" (p. 292).

The cultural consumption practices surrounding movies and music in Las Balsas merit a brief discussion. García Canclini (2001) argues that "when we consume we also think, select, and reelaborate social meaning" (p. 26). If so, then what social meaning can we draw from the cultural consumption in Las Balsas? To begin with, the types of movies watched in Las Balsas are typical of popular movies played in most parts of Ecuador. These are the American action movies that are constantly played at high volume on interprovincial buses, the main form of public transport. In this sense, watching American media connects the community to the same type of entertainment being enjoyed by their compatriots. García Canclini argues that the economic power wielded by the US has been behind the increased "Americanization" of aesthetic and cultural values in countries around the globe. Taste in music in Las Balsas however is much less Americanized, most likely because music is not easily dubbed, whereas movies are. Thus it is clear that Las

Balsas is not unique in its cultural consumption practices, but rather serves as an example of the widespread phenomenon of the globalization of media-related cultural activities.

In Mexico, as well, appliances like TV and radio have significantly altered people's use of free time. It is now the case that "the majority of people receive their information and entertainment more from a dislocated, international system of cultural production than from culture linked to particular territories and local products specific to them" (García Canclini, 2001, p. 74). This is not only a problem in Mexico, or even just in Latin America. European countries also struggle with the Americanization of media.

García Canclini (2001) cites one French television executive who argues that without potato production, France will still be France, but if they stop speaking French and lose the cultural narrative of their cinemas and theaters, France "will become just another slum suburb of Chicago" (p. 102). This highlights how cultural consumption is perceived differently from the consumption of goods. According to García Canclini, in many countries subaltern and hegemonic groups now separate themselves "by a differential affiliation with cultural subsystems" as opposed to differentiating "between one's own and imports, or between the traditional and the modern" (p. 45). García Canclini shows that increasingly identities and alliances are formed around international affiliations for popular versus elite tastes, rather than around national tastes.

Since the majority of the population in Latin America gets their information and entertainment from the mass media, García Canclini (2001) argues for the implementation of public policies that promote "cultural development and integration" in the mass media, instead of only focusing on high culture as has traditionally been done

(p. 129). He envisions a renegotiation of free-trade agreements that, by allowing for quotas on nationally produced films, might help revive national culture industries by protecting them against the economic hegemony of Hollywood productions with their formulaic plots. While this is a discussion that takes place far outside of Las Balsas, I mention it briefly in order to highlight the international context that helps explain the cultural consumption practices behind the selection of movies in Las Balsas.

DIGNITY

We live here with our children . . We are not animals . . . We deserve to live like citizens.

Aquí vivimos con niños . . . no somos animales . . . necesitamos vivir como ciudadanos.

-Las Balsas resident

One aspect of sufficiently improving quality of life is that it seems to be connected to the perception of dignity on the part of those affected. While dignity is admittedly hard to define, and changes dramatically depending the time or place, I think this is the most accurate term. The quote at the top of this section expresses an idea that I heard various times throughout my time in Las Balsas. When referencing the lack of infrastructure, the two most obvious being lack of roads and grid electricity, this comparison between humans and animals was often brought up.

Another time, a man who lived about an hour's walk downriver in a community that has no electricity was blaming the lack of infrastructure on the fact that they live within a reserve. He referenced the common theme that many from the area felt, that

Illustration 4.1: Las Balsas hosts an evening community get-together, followed by a dance party for all the youth from surrounding communities

protecting the local flora and fauna was more important to the government and foreigners than was caring for them and their families. He again made explicit the distinction between humans and animals, saying, “Human beings live here as well, not just wildlife.” (*Aquí viven seres humanos también, no solo seres salvajes*).

This connection that Las Balsas residents make between access to electricity and dignity is not that surprising when understood properly. During the era of Peronism in Argentina Peronist officials repeatedly made references to how dignity was connected to an enhanced level of well-being, mainly through increased access to consumption of consumer goods. Essentially “references to the vida digna [dignified life] reveal how Peronists reformulated understandings of justice around an ideal of enhanced citizenship and elevated living standards” (Elena, 2011, p. 8). Like Elena (2011) I do not mean for the term “dignified life” to be used normatively, but rather as a way to discuss how “national inclusion and progress” is viewed (p. 8).

Through studying the effects of Peronism on Argentina, Elena (2011) attempts to answer what it means to live with dignity in a modern society. Throughout this thesis I have shown that access to electricity is increasingly seen as a right, not merely a privilege. Drawing further on Elena’s ideas from Peronist Argentina, I argue that the quotes I provided above show that people living in the Mache Chindul Reserve are skeptical of any governmental talk of social and economic progress when their living conditions are “incompatible with basic notions of human dignity” (p.45). While Elena never really succeeds in answering the question he poses, it is an important question. I will not attempt to answer it either in any detail, except to say that it is clear from my

research that the people of Las Balsas and the surrounding communities see lack of access to infrastructure, specifically electricity and roads, as a mockery of their dignity.

According to many of those who live in Las Balsas, the most straightforward answer to their economic problems is the lack of roads. Admittedly the lack of road infrastructure is one of the biggest problems facing the entire Latin American region as governments and NGOs attempt to improve social and economic conditions. This is key, because infrastructure that provides accessibility is the only direct link "between those who seek opportunity and the opportunity location" (Keeling, 2002, p. 89). I have already recounted the stories of residents who enumerated how much more money they could make if only they did not face such an arduous and time-consuming trip to market.

The problem is of course complicated by the fact that the community is located within an ecological reserve and the government does not see a strong enough economic imperative to further develop the region. Dodson & Gentry (1991) show how deforestation in the region was correlated with road construction in the 1970s. The Ecuadorian government is clearly aware of this. Furthermore, part of what protects the community's natural resources from outsiders is the lack of accessibility. In addition to increased logging, increased hunting and fishing pressure would certainly further decimate the already-diminished wild boar, *guanta*, and fish populations.

It is true though that the Ecuadorian government has not shown a very strong commitment to environmentally preserved areas when it has large economic interests at stake. When the Yasuní-ITT Inititative, in which Ecuador would not drill for oil in the Yasuní Reserve in exchange for funds from the international community, failed to gather

funds, the president gave the go-ahead to drill for oil (El Universo, 2013). According to journalists the government is advancing with oil-drilling plans deep inside the Yasuni protected area, considered to be one of the most biodiverse areas on earth (Robinson, 2014). It recently came to light that even while waiting for international funds for the unprecedented Yasuní-ITT Initiative, the Ecuadorian government was secretly negotiating a deal with a Chinese bank to drill for the Yasuni oil (Hill, 2014). With the Ecuadorian government seemingly focused on macroeconomic projects, residents of Las Balsas and the surrounding communities are caught between their own desires for development, both social and economic, and the international attention and concern directed towards the preservation of the Chocó Forest.

Chapter 5: Conclusion

It is commonly accepted that broader access to electricity will be crucial in meeting the Millennium Development Goals, and solar PV home systems are a promising technology to help fill that need. While solar home systems can have significant impacts on social life, culture, entertainment, and potentially economics, they also suffer from serious limitations. Two of the biggest limiters of a widespread application of PV technology is the initial price as well as the access to technical knowledge for maintenance. While projects are sometime easily installed by generous donor contributions, the long-term upkeep is often too costly for local users.

Through the work of other researchers I have shown that when PV home systems are installed using the market it is mostly the middle class who benefits while the very poor remained isolated from electricity access. This shows the need for subsidies, either through governments or private donors, in order to help provide electricity to the 1.3 billion people still lacking access. This is where NGOs like FEDETA can make a substantial difference. It is important though that organizations commit to technical support of the PV technology to ensure long-term project success.

I have shown how solar PV technology is utilized in a rural setting to meet a demand for electricity. I find that the impacts of electricity in Las Balsas are best summarized as an improvement in standard of living by providing mostly "culture energy services" (Gustavsson, 2008). While one household actively uses the electricity for an income-generating project, the main cited and observed use for the electricity was

lighting of houses at night. This affects ability to study, read, do household chores, and socialize at night. Secondary uses include watching movies/TV, playing the radio or listening to music, and powering appliances like refrigerators and blenders.

These changes may seem mild compared to standards held by someone living in a wealthy region, but they are very significant to someone living in a rural area, hours away from the nearest urban center. People generally felt less abandoned since acquiring access to electricity and enjoying the ensuing benefits of feeling more connected to the rest of society through increased cultural consumption.

While current advances in PV technology hint that prices will continue to drop, the technology is evolving slowly. One particular promising technology, called thin-film solar, is promising to become much more affordable in the coming years. This is the same technology that first appeared powering small devices like calculators, and it is now starting to challenge traditional silicon-based solar PV panels. Thin-film solar consists of PV material laminated onto a thin and flexible substrate, and therefore can be mass-produced. While cheaper to produce, this technology is unfortunately less efficient than traditional PV technology.

However, energy storage is still the main battle to be faced. While panels often have a life of at least 30 years, batteries in PV home systems have a much shorter life expectancy. Replacing them can be prohibitively expensive when users are earning only a few dollars per day. This lack of storage is particularly important to rural areas of developing countries where the main use of electricity is still for evening lighting and entertainment, and no grid access is available.

After comparing solar PV home systems and microgrids to grid electricity I have concluded that generally a grid connection, whenever feasible, provides much superior access in quantity of electricity available, and in many case proves to be more reliable over the long term as it can be extremely difficult to finance and maintain a local autonomous electricity grid whenever external assistance fades away, as it almost always inevitably does. However in those cases where grids are just too cost inhibitive, solar home systems can provide electricity, albeit in a lesser quantity, to communities that otherwise would be excluded completely.

Finally, although electricity is not a panacea for all development problems, it is a crucial part of enabling poor rural communities to be able to maximize their potential and to be able to more fully participate in society. Access to electricity and the culture energy services it makes possible are key parts of any community's trajectory in improving quality of life. The fact that Las Balsas' electricity needs would be better served by grid electricity, were it available, is a key lesson in the current capabilities of off-grid solar PV home systems. While extremely useful for at least providing basic electricity services in areas with absolutely no grid access, small-scale PV projects should not necessarily be promoted as the best answer for poor rural communities just because they are a source of renewable energy.

It is true that solar PV panels greatly reduce the amount of environmental pollution compared to electricity based on fossil fuels, but is an insult to insist that the rural poor are best served by solar power, solely because it is renewable, when it provides an inferior amount of electricity. Each community will have unique needs, thus specific

solutions will necessarily be contextual. The real challenge in meeting the electricity-access needs in the Global South does not lie in finding a one-size-fits-all technology, but rather in learning how to appropriately deal with situation-specific energy needs.

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